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ENTITLEMENTS AND PRODUCTIVITY: RESEARCHING THE LEVEL AND DIVISION OF THE FRUITS OF PROGRESS

Volume I

By

Timothy Wayne Kelsey

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ABSTRACT

ENTITLEMENTS AND PRODUCTIVITY: RESEARCHING THE LEVEL AND DIVISION OF THE FRUITS OF PROGRESS

By

Timothy Wayne Kelsey

The crucial factors influencing the type of productivity change which occurs and the distribution of benefits from such change often are decided before production and consumption, the common focus of income distribution theories. Mainstream approaches, including transactions cost analyses, have been inadequate to deal with the complexities involved in change, concentrating instead on behaviors within a given structure of entitlements after the pattern of distribution has already largely been decided.

This dissertation develops a descriptive framework for analyzing productivity change and income distribution which includes how a structure of entitlements arises, how it is changed, and how this directly affects incentives for research and development, productivity change, and production and consumption, as well as income distribution. The framework involves a rich milieu of factors, including interdependence, conflict, means of choice, power (economic, political and administrative), knowledge, research and development, and production and consumption choices. It is compatible with mainstream theories, and can be viewed as pushing traditional economics into dynamics.

Timothy Wayne Kelsey

Two case studies are examined with the framework: an ex ante analysis of Bovine Growth Hormone (bGH or bST), and an ex post analysis of the mechanical cucumber harvester.

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This dissertation would not have been possible without the assistance, advice, and support of others. I want to thank my dissertation committee for all that they did to help me. I am indebted to them for their expertise, for indulging me during misdirections I chose to pursue, and for their openness to an unusual topic even though it meant more effort on their part to review my efforts and suggest paths around roadblocks. The committee included Jim Bonnen, Harold Riley, Warren Samuels, and Al Schmid. I am especially indebted to the committee's chair, Jim Shaffer, who among other things, provided the suggestion for the title.

I would also like to thank others who helped me complete the dissertation. These include Al Shapley, who took me on a tour of cucumber farms and grading stations, and introduced me to people in the cucumber subsector; Gary VanEe and Hugh Price, who provided information; and people in the cucumber subsector who patiently answered questions from yet another graduate student.

This research (as well as my doctoral education) was made possible through a USDA marketing fellowship. I hope this work and my future productivity will prove the fellowship to have been a good investment.

I would like to thank my parents for providing me initial support during my graduate experience, a place to stay during my frequent trips back to East Lansing to confer with my committee, and for their love and support.

Finally, this would not have been possible without the love and support of Alice, my wife. She endured the frequent times when I was hopelessly absorbed in the work, and encouraged me to take a break and enjoy a rest during those other periods when the words and ideas just would not fit correctly. Thanks for helping me.

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The mouse is a sober citizen who knows that grass grows in order that mice may store it as underground haystacks, and that snow falls in order that mice may build subways from stack to stack... To the mouse, snow means freedom from want and fear.

...(A rough-legged hawk) has no opinion why grass grows, but he is well aware that snow melts in order that hawks may again catch mice... to him a thaw means freedom from want and fear.

Aldo Leopold, A Sand County Almanac

When economists talk about their discipline as a theory of choice and about the menu of choices being determined by opportunities and preferences, they have simply left out that it is the institutional framework which constrains people's choice sets.

North 1981, p. 201

Chapter 1

Introduction

The dominant characteristic of American agriculture has been productivity change. Mechanization, chemical herbicides and pesticides, biological breakthroughs, and new management practices have radically transformed farm productivity, increasing output per acre and per worker, reducing the proportion of Americans on the farm, and providing consumers with a steady supply of food at low prices. This direction of change likely will continue.

It is clear that productivity change can yield great benefits, but that the benefits do not accrue equally to all. Change also brings hardship for some unable or unwilling to adjust, at the same time it brings windfalls to others. Because the direction (and type) of change can be influenced by economic actors with obvious impact on income, the distribution of benefits (and losses) from productivity change is particularly important. Both change and the distribution of benefits are not inevitable, but are products of human choice and thus alterable.

Evaluating productivity change (determining what happened, why it happened, and if that was a good thing to happen) is difficult because income is a sensitive issue and scientific methods cannot wholly avoid value judgments by the researchers. Even avoiding the value judgments in interpreting the normative value of a studied change, different approaches perceive the situation in disparate manners, through choices of boundaries of study, causation, and methods of comparison (numeraire and the standard of comparison). The "appropriate" approach of analysis depends upon personal judgments, not on a value-free objectivity, because science itself does not exist separate from leaps of faith and from its temporal and cultural context.

Science can never be more than something we believe in. The beliefs by their very nature are normative in character because they claim universal validity (Polanyi 1966 p. 66). The judgments are unavoidable, and what is "known" can never be separated from the perceptions, expectations and experience of the "knower." These include how the world is named and experience is organized, the causal relationships and prime movers perceived (Kuhn), and the standards for judging whether a result is significant (McCloskey).

The value dependency of science does not mandate that we do nothing or that science is meaningless. Science beliefs are not entirely arbitrary, but "must also be responsible beliefs, held in due consideration of evidence and of the fallibility of all beliefs" (Polanyi 1966 p. 66). "As scientists," Polanyi says, "we must seek a truth which is unambiguous and universal, even though at the same time we

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must recognize that this is impossible and, indeed, strictly speaking, meaningless..." (1966 p. 77-78).

The subjectivity of knowledge means several things for economics. Because analysis reflects, in part, the perspective and interests of the researcher, policy research can never be wholly value free. Value judgments influence how the case is perceived, the problems discovered therein, as well as the possible policy responses. Economics unavoidably is a player influencing that which it studies, by helping focus attention on some interests while ignoring other interests. It is part of the normative and valuational processes of society (Samuels mimeo p. 8), legitimizing and denying claims.

Secondly, other scientific approaches to a problem can be as appropriate or useful as the mainstream approach. The choice between approaches depends upon the subject area, what is desired from the study, and other judgments by the analyst. A mainstream approach does not necessarily reflect more scientific rigor or usefulness than others, unless "truth" is a product of strength in numbers or some other arbitrary decision rule.

Agricultural economists have been interested in the distribution of benefits from productivity change, primarily relying upon Neoclassical approaches for analysis. These methods generally abstract from the institutional context of the marketplace, focusing instead on production and

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consumption choices made within the market's institutional constraints. They attempt to predict what will be "chosen" (production and consumption) within this context, not determine what are the choices. This latter seems more important to me for policy analysis.

It is clear that the context in which market behavior and change occurs has influence on the distribution of benefits as well as what occurs and the size of benefits and losses. The distribution of resources before market activity (a product of this institutional context) most influences economic outcomes (Buchanan 1977 p. 70-71; Thurow 1973 p. 61), including the productivity of resources. Discovering the choices involved in productivity change and income distribution requires looking at this context.

Productivity change can arise from changes in endowments or effective entitlements, as well as affect actor's claims on income. Analyzing the immense complexity of change associated with technical innovation requires considering these "rules of the game" and "structure of payoffs" in the market as much as the behaviors within that market context, because productivity change influences and arises from all these levels. The Neoclassical approaches only focus on the market-level choices, generally disregarding the importance of the institutional choices that provide the market context. Analysis of productivity change and income requires explicit consideration of this dynamic institutional structure because of th

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of the large role it plays in determining what change can occur as well as the entitlement to benefits from change.

A. Present Focus

The purpose of this dissertation is twofold: to consider the methodology of analyzing productivity change and what this means for distribution analysis, and to create a descriptive model of productivity change and income distribution as an alternative to more prescriptive approaches. The methodological considerations will draw upon the nature of science and help identify the theoretical and empirical difficulties involved with analyzing productivity change and income distribution. The descriptive model will attempt to deal with these limitations, but just as all other approaches are limited by the value decisions required in analysis and by their cultural context, this can never be the "definitive piece" on productivity change. The appropriateness of an approach can never be an objective truth, but will always depend on value judgments.

Four major themes are interwoven throughout the dissertation. Firstly, choice is involved in the distribution of benefits as well as the direction and type of productivity change. These choices are more than the mere in-market choices (production and consumption) typically considered in Neoclassical Economic analysis, and are based on more than relative prices (in part because they define those relative

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prices). Secondly, rules affect whose interests are reflected in the market. Markets are sets of rules and regulations. The decisions about what rules and endowments should exist are one of the major vehicles for affecting the direction of change and the distribution of benefits. These entitlements to income are by nature dynamic and incredibly complex, requiring explicit attention instead of the typical perfunctory remarks or abandonment to political science.

Thirdly, an unavoidable difficulty with analysis of productivity change is the relativity of the variables under study. Productivity, prices, income, and efficiency, among others, receive definition from the market rules (see, for example, Arrow 1983 p. 26; Boulding 1977 p. 820; and Samuels 1978 p. 102-3). Allowing these rules to change makes numeraires vital but difficult to create. Productivity change depends upon the effective entitlements, both for the definition and for the level of effort. Fourthly, values are involved in analysis, making analysis more difficult. There is no "correct" way to define or constrain the problem, making a multitude of approaches equally valid. The choice between the alternatives depends upon what is deemed appropriate to look at. Unfortunately, the choice of approach affects what is discovered.

Research into the relationship of productivity change and income requires explicit recognition of the roles of the institutional elements in agricultural markets: power (both political and economic) and its ability to influence participants' opportunities (Argersinger 1984; Galbraith 1973; Kanel 1974; Marion 1979; Matthews 1985; Mueller 1983; Pen 1978; Preiser 1971; Price 1983; Randall 1974; Samuels 1981, 1982; Shaffer 1975), property rights and who determines which factors are considered relative inputs, as well as who is able to claim returns to those factors of production (Furubotn 1972; Parker 1980; Meade 1969; Randall 1972; Samuels 1981; Shaffer 1966; Seidman 1973; Schmid 1987), the nature and incidence of transactions costs (Schmid 1986b, Olson 1977; Williamson 1985), and the factions within the economy (Pope 1986; Olson 1977), as well as who decided that change was necessary (Ezekiel 1957; Price 1983 p. 10; Melman 1975; Carter 1985 p. 799; Samuels 1977, 1982; Schmookler 1965; and Seidman 1973). It is this realm that determines the direction and form of productivity change, and the entitlements to benefits.

B. Clarification

Several clarifications should be raised. This descriptive approach is a political economy model focused more on human relations than on commodity relations, contrary to Neoclassical analysis. It is not meant to replace production economics, but to be used for policy analysis by helping understand the context of markets and the nature of the choices within that context.

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Similarly, this approach is meant to be descriptive, not prescriptive. It attempts to describe the mechanisms that influence who benefits from productivity change, not to judge whether these mechanisms are good or bad. The exploration should not be taken to connote support or disapproval for what exists, nor for how the world ought to be.

The approach developed here is not necessarily inconsistent with production economics or Neoclassical analysis. It differs primarily by looking more precisely at what is usually taken as exogenous by these other approaches. The approach explores the context in which production economics and Neoclassical analysis reside, to more fully investigate the effective distribution of resources before market activity which many Neoclassical proponents recognize as influencing economic outcomes (a distribution resulting from rights, rules, organization, and the nature of the goods involved).

C. Outline of What Follows

Ideally the dissertation should look at a large number of different productivity changes and research approaches, but there is neither space nor time for such expansive analysis here. Productivity change and income distribution is close to the center of economic concerns, so the associated literature is voluminous. To make the study manageable the methodological influences on analysis will be explored through a

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a review of the major approaches to analysis, followed by an illustration of their influences through review of the plethora of studies on the mechanical tomato harvester.

An institutional approach to describing change will be developed and then applied to two case studies, one ex ante and one ex post. These case studies serve to illustrate the institutional complexities and influence involved in productivity change, as well as the difficulties of analysis.

The mainstream approaches to evaluation of productivity change and income distribution will be explored in Chapter 2. They will be presented and then critiqued. These include the Induced Innovation Hypothesis, Economic Surplus, and Marginal Productivity approaches. Several institutional attempts at evaluating change will then be offered as an introduction to the ideas developed in a later chapter.

The problems of analyzing productivity change will be explored in Chapter 3. Nine studies of the mechanical tomato harvester will be reviewed and then used as an illustration of the influence of methodology, before outlining the empirical problems. Choices are required by the analyst to resolve these difficulties, with consequent effects on what is found and the conclusions. A summary of where the traditional approaches and these limitations leave us is then tendered.

An alternative framework for analyzing productivity change and income distribution will then be developed in

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Chapter 4, drawing upon institutional literature. This framework will attempt to clarify the types of choices involved in change. The implications for productivity, and for the distributive impact will then be explored, before briefly discussing the specific methodological difficulties and limitations involved with the approach.

The framework will then be used to explore two cases of productivity change, one about to occur (bovine growth hormone, or bGH), and one which has occurred (mechanical cucumber harvester). The case studies serve to illustrate the developed framework as well as the inherent difficulties of analysis.

The final chapter will summarize what has been done, before comparing this approach to Neoclassical conceptualizations of institutions. The conclusions will also make suggestions for how this framework can be applied.

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Chapter 2

Literature Review

A. Introduction

There are a diversity of approaches to analyzing productivity change and income distribution. These can be arbitrarily divided into Neoclassical approaches, which focus on production and consumption choices within a market context, and qualitative approaches, which pay more attention to that context. The former are deductive approaches, based on rationalistic models which are empirically tested. The latter can also be deductive, but include some inductive approaches that attempt to observe without rigid interpretation.

There are two general Neoclassical approaches to productivity change and income, both based on behavioral models. The first, Economic Surplus, attempts to estimate the "welfare" effects of change, and is clearly recognized as a normative approach. The second, production function based analysis (including Marginal Productivity Theory), attempts to estimate the real income effects of a change in productivity. Even though it does not overtly use values to interpret the welfare consequences of change, it does contain normative judgments influencing results (including choice of

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boundaries, relevant output, inputs, and causation. These will be discussed further later).

Both Neoclassical approaches limit the depth of analysis of productivity change and income because their focus is defined too narrowly. My chief objection arises from the way Neoclassical models are premised on the distribution assumptions inherent in their underlying model. They attempt to predict the allocation of resources given a market set of opportunities, rules, and potential payoffs, not notice what determines this structure itself. Vital decisions (overt and implicit) about the relationship of productivity change and income are made during formation of this market set of opportunities, however, not just at the level of supply and demand (Ayres 1957 p. 26; Beckford 1984 p. 80; Bieri 1972 p. 801). Their focus just on the market level choices and transactions misses the richness of mechanisms and choices that determine the market's institutional context, and thus the nature of change and distribution.

The Induced Innovation Theory is a good illustration of the Neoclassical approach. This explanation of change flows directly from the focus and assumptions of Neoclassical theory, asserting that choice between alternative directions of change is important but made purely on the basis of shifting relative factor prices. The theory will be explored and then critiqued, recognizing that the critique is equally applicable to the analytical methods of Neoclassical theory.

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These methods will then be reviewed and evaluated in light of the earlier critique. Several qualitative approaches to change will then be investigated, before considering where this leaves us.

B. Induced Innovation Hypothesis

Induced Innovation theory, both of technical change and institutional change, recognizes that there are multiple paths of change and that choice between those paths is important for determining the type and degree of change which occurs. It hypothesizes that these choices are made purely on the basis of relative factor prices, not through the exercise of power or other institutional influences. "Efficiency" is seen as the sole criterion affecting change, an efficiency as defined by the market structure and institutions. Change is perceived as "guided along an efficient path by price signals in the market" (Hayami and Ruttan 1985 p. 88).

Hayami and Ruttan (1970) illustrate this by noting the respective technological developments in the United States and Japan. In the labor-scarce but land-rich United States most technological innovations in agriculture have been labor-saving machines, such as tractors, combines, and gang plows, while in land-scarce but labor-rich Japan the technology has been primarily land-saving chemical fertilizers and pesticides, and biological innovations. Hayami and Ruttan suggest that these disparate directions of innovation result fr

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from the widely different relative factor prices in the two countries.

The difficulty with this approach is that prices (and efficiency) do not exist in and of themselves: they are unique to an institutional and market structure, reflecting the distribution of resources, power, methods of price discovery, and other elements which determine the relative strengths of participants, permissible behaviors, and possible payoffs within a particular market. If these institutional elements change, the definition of efficiency changes.

The Induced Innovation Hypothesis and Neoclassical approaches to change concentrate on the choices and behaviors within a market only <u>after</u> important choices have already been made about the structure of rights, endowments, rules, and status quo technical relationships that compose that market. These prior decisions are vital influences on productivity change and the distribution of income, and their omission limits the understanding of <u>why</u> and <u>how</u> change occurs.

What substantively is "optimal" and "efficient" depend upon whose perspective is taken, because they vary among individuals. These decisions are not only made in the market, but occur more importantly <u>outside</u> the market by determining the relative weights (via endowments and rights) of individual's preferences, as well as the rules by which preferences can be expressed and decisions made. Relying upon relative factor prices to explain the choice between

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alternative paths of change only recognizes the market-level decisions while ignoring the vital and influential decisions that created that market-level structure in the first place. It takes the status quo distribution of power and income for granted, without evaluation. It does not even adequately represent market-level decisions, because its rationality assumption disregards the possibility of power, tradition, and other potential influences occurring explicitly within market transactions.

This does not mean Neoclassical approaches are necessarily inconsistent with a wider perspective on change, only that the choices studied from the Neoclassical perspective occur within the context of these prior but equally influential decisions. The following critique of Neoclassical approaches and later development of an entitlement-based approach arise from this concern, and should be read in this light.

The empirical studies used to illustrate the Induced Innovation Hypothesis most often compare widely different resource situations, such as the United States and Japan. These corroborate the hypothesis that path decisions between widely divergent alternatives are influenced by factor prices, but are hardly rigorous tests. The Induced Innovation Hypothesis does little to explain the different directions of change in environments where factor prices are similar, or on what basis the choice is made when equally "factor-saving" but

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distributively dissimilar alternatives are possible. Any power of explanation diminishes as alternative directions of change become closer.

Whether the choice can be represented as a decision between an array of known possibilities is itself doubtful. Knowledge is a function of social organization and history, and scientific advancement often occurs more by serendipitous accident than by preconceived direction. Any array of possibilities is thus a function of past decisions and power, not simply an objective transformation curve faced by "society." Instead of taking the existence of possibilities for granted, it is important to consider how these are created as well as how decisions between them are made. Rosenberg (1976) suggests looking at the "compulsive sequences" of development, feedback mechanisms, and social processes.

In working markets we expect factor prices to transmit and stimulate changes in institutional structure, technology, supply and demand. Attributing the cause of change to factor prices, however, is tantamount to holding the messenger responsible for the missive. Even if change is induced by factor prices, holding factor prices as the cause is only half correct: those elements responsible for altering the factor prices must be considered the real forces of change, not the factor prices themselves. This is sometimes forgotten, as with Kislev and Peterson (1982), who solemnly claimed in one paper to have explained "virtually all of the growth in the mac

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machine-labor ratio and in farm size over the 1930-70 period by changes in relative factor prices without reference to 'technological change' or 'economies of scale'" (p. 578). They do not ask the next obvious question of what made those prices change.

Prices serve a communicative function, conveying demand and supply conditions, as well as the institutional influences associated with the specific environment in which the market exists: ownership patterns, price discovery mechanisms, traditions, etc. Factor prices similarly express these dynamic processes, including the forces involved in technological and institutional change. There should be little surprising in this, because the role of prices ostensibly is to reflect these conditions. That the direction of change is influenced by factor prices follows directly from the _role_ of prices.

It should be clear that actors' behavior influencing economic performance consists of more than just consumption and production decisions. People attempt to influence their welfare by altering the structure of market opportunities through the exercise of political power, as well as by action _within_ a market as Neoclassical theory usually assumes. For actors to ignore their ability to alter the range or size of payoffs through power would not be rational.

Specific examples of power changing market payoffs and opportunities abound: the use of the Sherman Act to prevent farm

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farmers from organizing; dairy cooperatives pushing for creation of the Capper-Volstead Act to give them that right (Guth 1982); the creation (and later disbanding) of the Federal Tart Cherry Marketing Order; farm workers displaced by grain binders threatening farmers to stop adoption by burning equipment and barns (Argersinger 1984); the court case about the University of California agricultural mechanization research, in which the plaintiffs argued the research should be focused on smaller producers; "strikes, slow-downs, and what not" by the International Longshoremen's and Warehousemen's Union which helped compel compensation for technological change (Schmitz & Seckler 1970 p. 575); changing interpretation of patent laws to include coverage of genetic innovations; consumer-oriented groups bringing suit in U.S. District Court to overthrow the USDA's regulation on mechanically deboned meat (McNiel 1980); and political lobbying by the American Farm Bureau, National Farmers Organization, and other parties interested in influencing and sustaining federal farm programs (Fuller 1969). All involve market changes either by redefining who can be an actor (Sherman Act, Capper-Volstead, marketing orders, collective bargaining), the types of technology created or compensation needed for adoption (grain binders, UC court case, Longshoremen), output (patent laws, deboned meat), or the size of income transfers (political lobbying on farm programs), and all influence the size and distribution of income.

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Changes in rights, endowments, rules and technical relationships (what I call institutional context) become important from this perspective because these alter the relative ability of market participants to articulate preferences. These help determine the definition of inputs, outputs, and thus productivity. Behavior from this perspective includes political and economic power (ability to change the structure) and consumption and production decisions, as well as where the relative ability to make these decisions arises.

The definition of inputs, output, and thus productivity are dependent on the institutional context, and change as the context changes. This includes definition of the thing itself, as well as endorsement of being actively involved in the production process. Different claims on output can elicit different levels of effort (as recognized by Efficiency Wage models, and by the incentive problems associated with an equal distribution of income), opening the possibility of "productivity change" merely because of changes in ownership.

Inputs do not exist in and of themselves, but are a function of the institutional framework, especially knowledge. For this reason DeGregori says resources "aren't" but that they "become" (1986; 1987), and Kenneth Parsons argues that the physical world is not things but uses and costs. Productivity is not inherent in the good (input) but is a value formed by institutional and technical relationships.

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Inputs and outputs cannot be readily separated from the procedural rules and knowledge that give definition to them, making comparison across time difficult. This will be discussed more in depth later.

C. Neoclassical Analytical Approaches

The two major Neoclassical approaches to productivity change and income are Economic Surplus and production function based theory. Economic surplus will be briefly discussed, but implications will not be drawn because it is irrelevant without the leap of faith that it measures welfare. The primary production function theory, Marginal Productivity Theory, will then be outlined, with a view of applications and implications.

1. Economic Surplus

Economic Surplus has been a popular technique for estimating the returns to agricultural research, spawning many different studies.[1] Despite this acceptance, it remains a

[1]Griliches (1958) on hybrid corn; Schmitz and Seckler (1970) on the mechanical tomato harvester; Ayer and Schuh (1972) on cotton in Brazil; Akino and Hayami (1975) on rice in Japan; Hayami and Herdt (1977) on semisubsistence agriculture in the Phillipines; Scobie and Posada (1978) on rice in Colombia; McNiel (1980) on mechanically deboned meat; Edwards and Freebairn (1984) on exportable commodities; Cooke (1985) on the mechanical cucumber harvester; Offutt, Garcia, and Pinar (1987) on corn; White (1987b) on agricultural research; Unnevehr (1986) on rice in South East Asia; Norton, Ganoza, and Pomareda (1987) on research and extension in Peru.

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controversial technique, generating large volumes of negative acclaim from a very wide range of economists[2] (see Currie 1971). "'Probably no single concept in the annals of economic theory has aroused so many emphatic expressions of opinion as has consumer's surplus; indeed even today the biting winds of scholarly sarcasm howl around this venerable storm centre'" (Pfouts 1953, in Currie 1971 p. 741).

Economic Surplus appears as a relatively simple concept: the difference between what people pay (producers receive) for a product and what is estimated they would have been willing to pay (receive) for that same product is used as a quantitative measure of welfare. Demand and supply curves estimate this willingness, making calculation relatively easy. Estimations of the "surplus" arising from a change can be readily deduced merely by estimating demand and supply curves and then doing a few algebraic calculations.[3] Consumer surplus and producer surplus are explicit value judgments of the results of change because they purport to measure "welfare," not objective measures of the distribution of effects.

[2]For general critiques of Economic Surplus, see Silberberg (1978); Little (1950); Cochrane (1980); Currie (1971); and Willig (1976).

[3]There are further relevant considerations, including the type of shift involved in the case (parallel, divergent, convergent).

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Economic Surplus suffers from the institutional neglect mentioned earlier, because supply and demand curves are static representations of the conditions unique to the market's institutional structure. Demand curves, for example, express effective preferences, a function of the institutional structure which weights participants' abilities to articulate preferences. Lack of demand may mean either no desire to purchase, or an inability to purchase because they lack the resources.

This means the weights on individual welfare reflect the weights implicit in the institutional context, or whose preferences count and whose do not.[4] The results can have no more moral weight than the market's institutional structure defining rules, endowments, and actors.

Comparisons of pre- and post- change situations are theoretically unjustified, even though Economic Surplus analysis is premised on such comparisons. Tastes, preferences, and endowments must be assumed fixed by the procedure. Demand curves, supply curves, inputs, outputs, and even prices are institutionally dependent variables, whose meaning varies as productivity change alters participant relationships (relationships determined, in part, by power, property rights, technological feasibility, transactions

[4]"An individual with no income or wealth may have needs and desires, but he has no economic demands" (Thurow 1973 p. 57) or consideration by Economic Surplus analysis.

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costs, and other institutional factors). New demand and supply curves (and the areas beneath them) do not have the same meaning as the old, complicating the possibility of comparisons between states. The "social welfare" purportedly measured is not comparable, making "loss" or "gain" unknowable.

To be fair, many economic surplus studies do note institutional influences, recognizing their importance. Unfortunately these concerns usually appear as qualifications after the analysis is completed, primarily to determine the direction of bias. Hayami and Herdt (1977), for example, noted that "a real danger would arise if new technology was monopolized by a small number of large producers, without causing a significant shift in the aggregate supply schedule. In such a case, the large farmers could capture the whole gain of technical progress by increasing output without a resulting decline in prices" (p. 255). But they did not explore the crucial questions this suggests about who <u>decides</u> on the type of technology introduced, as well as the effective accessibility of new technology to small or poor producers due to power disparities, lack of effective resources, or scale differences.

Ayer and Schuh (1972) suggested that the reason the innovation they evaluated even existed was because the state legislature was in the hands of rural landowners and farmers (p. 566), a consideration which requires much more than the

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perfunctory comments they give it. Freebairn and Edwards (1982) stated that "results are modified, but not overturned, when the perfect competition assumption is relaxed" (p. 45), but provided little indication of the degree of resulting modification.

Finally, even though Economic Surplus is a normative technique, the value judgments involved are usually not explicitly apparent. "Social benefits", for example, are meaningless without stating the basis of the definition, because the value term "benefit" clearly depends on individual perspectives and judgments. A generic "social benefit" without regard for who receives it ignores the diversity of conflicting interests in society and the difficulty of achieving societal agreement on "social good", and requires strong value assumptions about whose preferences should count. If the distribution of benefits across groups is considered, the unavoidable necessity of weighting the benefits, whether equally or unequally, involves more value decisions (Bieri 1972 p. 803). Furthermore, using market prices is a tacit value judgement that the status quo is best. It says "at bottom... justice is what power can get in the market. It thus takes a particular, if complex and ambiguous, ethical position with regard to the issues of the larger paradigm of choice and power" (Samuels 1981 p. 51).

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2. Marginal Productivity Theory

Other Neoclassical analyses of productivity change and income attempt to avoid normative difficulties by focusing on real income changes without imputing how this income affects actors' welfare. The approach avoids the dubiousness of estimating the welfare effects, or of interpersonal comparisons of that welfare.[5] The Neoclassical theory of income distribution, Marginal Productivity Theory, attempts to calculate the contributions to production and income returns to those contributions, using theoretical estimations of the factor relationships of production (production functions).

While recognizing the importance of power in distribution (1971; 1978), Pen still considers Marginal Productivity "a plausible starting point for the explanation of most income" (1971 p. 86). This makes it a good place for us to begin as well. The theory will be reviewed, paying particular attention to what it can say about technical relations. Two simple models will be presented which illustrate the dimensions of Marginal Productivity Theory, before considering

[5]This holds true as long as real income is not used as a surrogate measure of welfare.

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what these suggest and do not say about income distribution and productivity change.[6]

Marginal Productivity essentially is an input demand theory, based on a conception of how entrepreneurs determine their level of input usage, given input prices. Supply is not considered directly. The size of distribution is estimated through price auction mechanisms, taking supply as fixed.

Marginal Productivity involves the usual assumptions of perfect competition, and can be estimated starting from a production function or a cost function. Given a production function Y = F(a,b), the marginal products of inputs a and b are

$\frac{\delta F}{\delta a}$ and $\frac{\delta F}{\delta b}$ respectively. The price of output Y is P.

$$\text{profit} = PY - P_b b - P_a a$$

or

$$\text{profit} = PF(a,b) - P_b b - P_a a$$

by substitution.

[6]This will not be a list of general criticisms of Marginal Productivity Theory, because such concerns are already widely prevalent in the literature. See Blaug (1986); Bronfenbrenner (1971 p. 186-188); Gordon (1980 p. 97-98); Knight (1951 p. 55- 57); Marglin (1984 p. 315-316); Okun (1975 p. 41-48); Peach (1987); and Thurow (1973 p. 70-73; and 1984).

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Differentiate with respect to inputs and set equal to zero:

$$\frac{\delta profit}{\delta a} = P\frac{\delta F}{\delta a} - P_a = 0$$

$$\frac{\delta profit}{\delta b} = P\frac{\delta F}{\delta b} - P_b = 0$$

Rearranging:

$$P\frac{\delta F}{\delta a} = P_a \qquad\qquad P\frac{\delta F}{\delta b} = P_b$$

This says that at "optimal" allocation (given all perfect competition assumptions) the value of marginal product will equal the cost to the entrepreneur, which is the input price. "Income" here is defined as the input price. This assumes that the entrepreneur adjusts quantities, not prices, as well as the other assumptions required by perfect competition. Note that the entrepreneur is not explicitly in the function, and that derived demand is the only demand in the analysis. Supply is also absent (it only works when supply is inelastic) in the sense that it cannot change.[7]

Whether the value of total inputs will exhaust the output value (here $P_aA + P_bB = PY$) is called the "adding up" problem, and it depends upon the homogeneity of the production function. A function of degree 1 is necessary for this to occur, a case called "constant returns to scale." This

[7]Bronfenbrenner says Marginal Productivity "...can serve as a theory of input prices (including wage rates) only in the extreme case of completely inelastic supply" (1971 p. 173).

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condition is said to be insured in the long run by the assumptions of perfect competition, rendering "adding-up" questions unimportant in Neoclassical analysis.

The marginal product does not necessarily predict the "wage" the provider actually receives. This is not a theory of wages (though earlier versions of Marginal Productivity overtly were a wage theory, these claims have been dropped). Bronfenbrenner suggests some reasons for this discrepancy "that do not involve 'exploitation'," as he puts it (1971 p. 173), including fringe benefits, on job facilities, or other costs to the employer.

Several interesting models can be built around this basic conception, quickly showing the possible relationships between inputs and output. Even though these models contain the same "within market" assumptions as Marginal Productivity, limiting their applicability, they are useful because of the ease with which they display "within market" relationships. The two are a one-sector and a two-sector model.[8]

a. One-Sector Model

The common one-sector model focuses on one good produced with two inputs. Demand for the good does not change here, implying that income distribution is solely determined by

[8]Also known as partial equilibrium and general equilibrium models, but these titles are misleading because they incorrectly imply that the rigid restrictions of partial equilibrium have been loosened in the general model.

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technology and factor supplies (H. Johnson p. 53). One-sector models which do include demand for the good can be created (see Binswanger 1980), but the conceptualization of demand is less complex than in two-sector models.

What is important here is to see how relative and absolute shares of income shift when the quantity (or price) of one of the inputs or the status quo technology changes. The range of results are often represented by the elasticity of substitution (σ), which is the "ratio of the proportionate change in the ratio (b/a) of relative quantities to the proportionate change in their relative prices (P_a/P_b)" (Bronfenbrenner p. 143). In English this means the percentage by which the input ratio b/a will change as a result of a 1 percent change in the price relation P_a/P_b (Pen 1971 p. 83).

$$\sigma = \frac{d(b/a) \ / \ (b/a)}{d(P_a/P_b) \ / \ (P_a/P_b)}$$

This model is illustrated in Figure 2.1. Let BA be the input price ratio, Y_0 the output, and b_0 and a_0 the level of inputs associated with Y_0 at this price ratio. BA can be used to represent the total value of output expressed in terms of one of the factors, so $0b_0/0B$ is B's share of total income and $b_0B/0B$ is A's share.

If the quantity of A increases to a_1, output increases to Y_1, and the relative share of income between A and B

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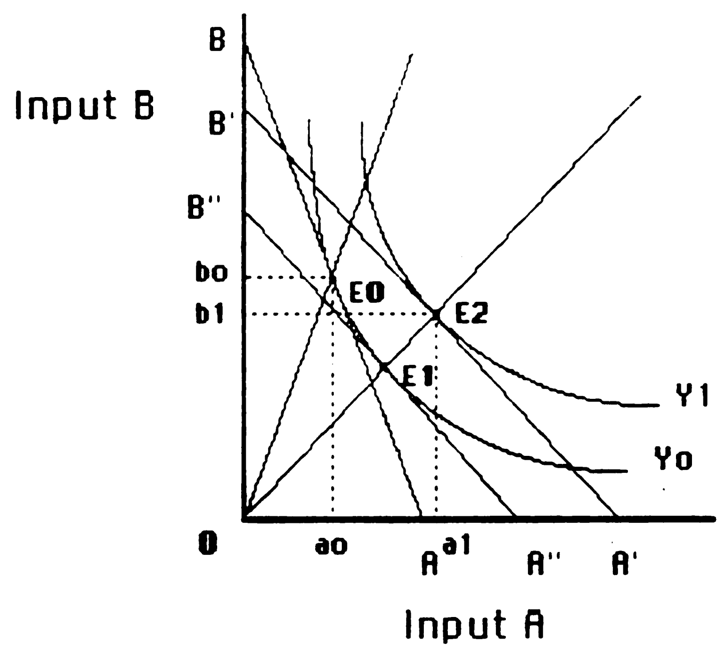

Figure 2.1 One-Sector Model

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changes. In this example A's share increases, but it could as easily decrease. "What happens to A's relative share clearly depends on both the increase in total output, (here E_0 to E_2) and the change in labor's relative marginal product or price, which is reflected in the change of slope between BA and B''A'' (H. Johnson p. 42). The shift from E_0 to E_1 is the substitution effect wrought by the relative price change, which is represented in the elasticity of substitution.

If $\sigma = 1$, the relative shares are unchanged because the change in relative quantities is just compensated by the relative price change; if $\sigma < 1$, the relative share of the increased factor declines, because the relative price change is greater than that of the relative quantities; and if $\sigma > 1$, the relative share of the increased factor rises for similar reasons. Productivity change within this framework can be represented in two general ways: disembodied and embodied change (or output-enhancing and cost-reducing change).[9] Disembodied change involves shifts of the production function, so more output is gained from a given level of inputs. Embodied changes involve shifts within the inputs themselves, often considered as increases in factor quality.

[9]Technical progress in output and technical progress in inputs, according to H. Johnson p. 45.

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i. Disembodied Productivity Change

The biases of disembodied change can be of three different types.[10] If the marginal product of both inputs increases proportionally, the change is called Hicks neutral because of the neutral effect on income (relative prices). This change increases the absolute share of income for both inputs in the same proportion as the change in output. Relative shares remain constant.

Technical change is considered biased when the marginal productivities do not change equi-proportionally to each other. A change is called B-biased or A-saving when it raises the marginal product of B more than A (equi-proportionally). The absolute and relative income of B increases as the use of B rises equi-proportionally, while the relative income of A decreases and the absolute income of A can be higher or lower (depending upon the size of the B-bias). A change is called A-biased or B-saving when it raises the marginal product of A more than B (equi-proportionally), with income effects the reverse of the above.

In terms of economic diagrams, "an innovation is A-biased and B-saving if it raises the marginal rate of substitution (m.r.s.) and the slope of the isoquant at the point (a,b); neutral if it leaves the slope and m.r.s. unchanged at this

[10]There are several definitions of bias in the literature, including Harrod, Robinson, and Hicks. This discussion focuses on Hicksian change, the most commonly used.

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point; B-biased and A-saving if it lowers the m.r.s. and the slope of the isoquant at this point" (Bronfenbrenner p. 153).

ii. Embodied Productivity Change

Embodied technical change instead sees quality changes in the inputs, not shifts of technical relationships. Inputs are seen as possessing a number of "productive units." As technical change occurs, the quantity of "productive units" within each individual input increases. In an agricultural example, single tractors may be viewed as embodying productive services, the quantity of which increase as tractor technology rises. Across time tractors are still tractors, but their productive contributions ("productive units," however defined) increase with technical change as their horsepower, fuel economy, and so forth rise.

Embodied change is neutral if the "productive units" of all the inputs increase equi-proportionally. Relative income is not altered but absolute income of each rises with such change. B-saving (A-biased) embodied technical change occurs when the "productive units" of B increase more than those of A, which causes the relative income of B to fall and of A to rise. The absolute income of B can increase or decrease, depending upon output effects. A-saving (B-biased) embodied technical change is the reverse of the above.

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b. Two-Sector Model[11]

Two sector models differ from one-sector models by giving output demand a greater role and by including two output goods instead of the one-sector model's single good. The distribution of income affects demand, which thus influences the distribution of income.

The model consists of two output goods produced from the same inputs but with different factor intensities. There are two consumers with different preferences, one of whom owns all of input a and one of whom owns all of input b. The model relationships can be developed mathematically or with Lerner-Pearce or Edgeworth-Bowley diagrams.[12]

The addition of demand feedback on income and of cross-sector influences creates results different than from the one-sector model. The primary difference is that given fixed factor endowments, "a sector can obtain additional factors only by withdrawing them from the other sector" (Binswanger 1980 p. 250). A neutral change in one sector (in the a-intensive sector, for example), which previously increased the absolute income of <u>both</u> factors in the one-sector model, now instead reduces that of b, the less intensively used factor. The change encourages the transfer of some of the

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[11]This entire section relies heavily upon H. Johnson, p. 52-72.

[12]See H. Johnson (1973 p. 53-79) for diagrammatic background and development.

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improved sector's intensive input, a, out of the unimproved b-intensive sector, reducing production there and freeing up more b than can be absorbed in the improved sector (because the freed input b is less intensively used there). The price of b must fall to restore equilibrium, which combined with the decrease in production in the b-intensive sector causes its absolute income to fall.

Technical change can be interpreted in two different manners with the two-sector model, both designed to restore competitive equilibrium to the model: output price falls, input prices remain constant, and consumers receive the benefits; or output price stays constant, and the improved factor's price increases.

i. Output Prices Fall

In the case where technical change causes output prices to fall, the effect on relative income depends upon the elasticities of demand. Summarizing from H. Johnson (1973 p. 68-69), with neutral technical progress in one industry, the relative price of the intensive factor will rise, be unchanged, or fall, depending upon whether the uncompensated elasticity of demand for that output is elastic, unity, or inelastic. If the change is biased towards the intensive factor, (saving the less intensive factor).the critical value of the uncompensated elasticity of demand which determines the outcome is something greater than unity, while if the change is bi

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is biased towards the less intensive factor (saving the intensive factor) that critical value is something less than unity.

ii. Input Prices Rise

If instead technical change causes the input price to rise while output price remains constant, the distributive consequences are harder to disentangle. The relative price of the input used intensively in the innovating sector must rise, and the relative price of the less intensive input must fall. This means that "more than all of the increase in social income produced by the innovation accrues to the factor used intensively in the industry that produces it, the owners of the other factor losing in absolute income" (H. Johnson 1973 p. 69).

If the technical change is Hicks neutral, the increase in the relative price of the innovating sector's intensive input will create a substitution effect with the other input in both sectors. The output of the innovating sector will increase, reducing output of the other sector. This is relatively easy to understand through use of a Lerner-Pearce diagram.

In Figure 2.2, R_0 is the endowment point of the economy, and BA the ratio of input prices. With constant returns to scale (as required by Marginal Productivity analysis) the expansion paths of production are R_x and R_y, respectively, with

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YY and XX illustrating the isoquants tangent with the existing relative prices. Actual levels of output can be discerned by drawing lines through endowment point R_0 parallel to the expansion paths, (R_x and R_y) and noting where they intersect the expansion paths. The level of output is measured by the distance from the origin, here OX_0 and OY_0. Vector addition shows that these insure full employment of inputs.

Figure 2.3 illustrates a neutral technical change in Y, which is a-intensive. Relative input prices shift from BA to B''A'', stimulating substitution of inputs and change in expansion paths for both goods. Production of Y increases from OY_0 to OY_1, and production of X falls from OX_0 to OX_1. The demand effect (not illustrated here) depends upon the tastes of the owners of input a: if their income elasticity of demand for Y is very elastic this could be an equilibrium without further price changes, otherwise the price of Y must fall for the market to clear.

If the technical change is biased towards the innovating sector's intensive input the effects are similar to but stronger than the above. The factor price increase is greater, with a larger output effect.

Technical change biased towards the less intensive factor will similarly raise the relative price of the intensive input, but output effects depend upon the relative sizes of the substitution effect and the bias of change. When the substitution effect is stronger, relatively more of the less

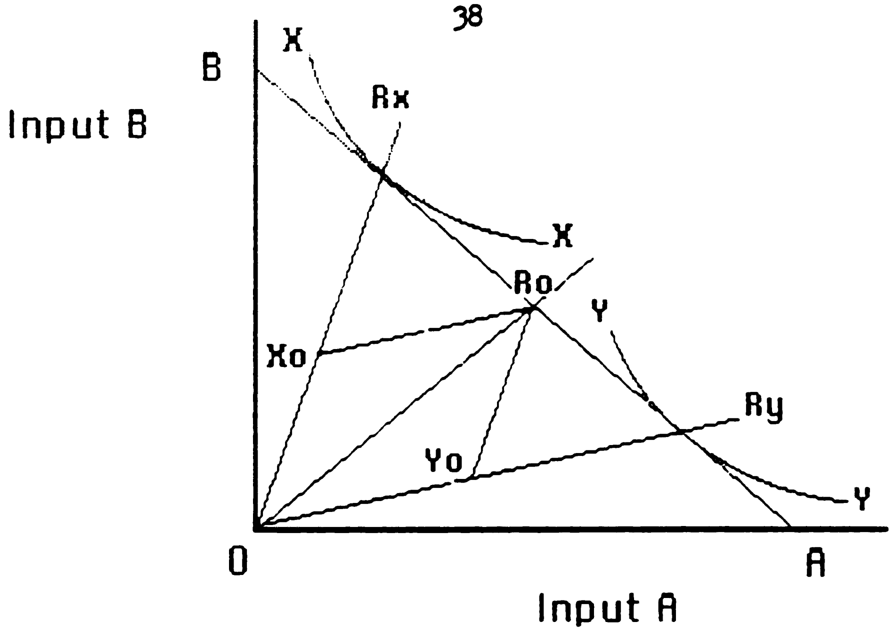

Figure 2.2 Two-Sector Lerner-Pearce Diagram

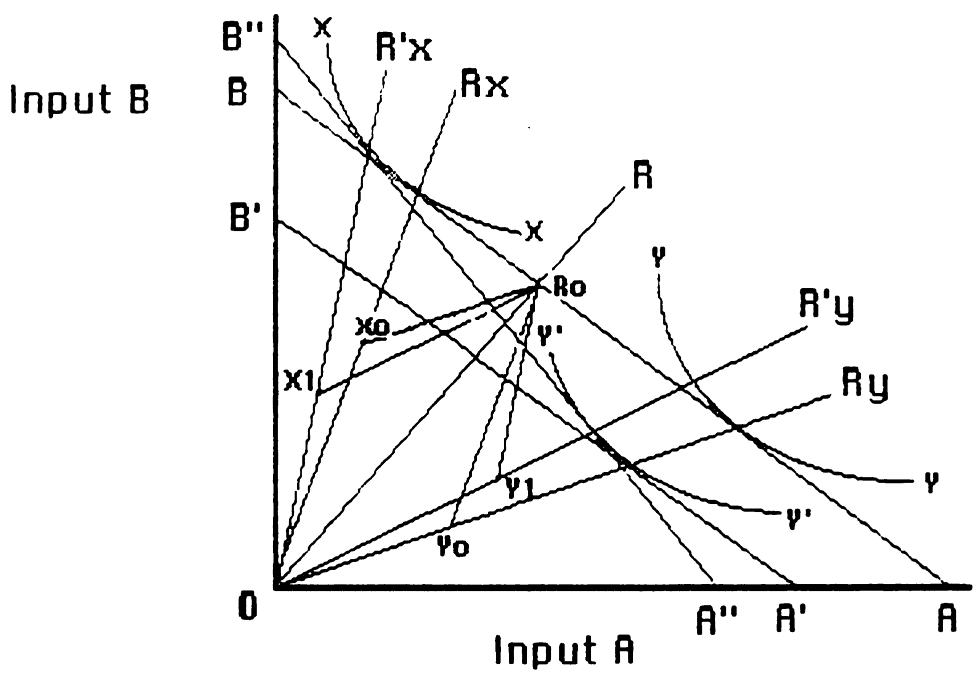

Figure 2.3 Two-Sector Lerner-Pearce Diagram with Technical Change in Y

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intensive factor is used (as in the above cases), increasing output and reducing the output of the less intensive good. When the bias is stronger than the substitution effect, relatively more of the intensive factor is used, reducing relative use of the less intensive and allowing increases in production of both goods. Output price changes needed for equilibrium depend upon the income-elasticities of demand of the factor owners.

3. Applications

a. Implications

It is possible to further differentiate possibilities by constructing other models, but these are sufficient for the purpose at hand. These models and marginal productivity are useful for understanding something about technical change and income, because they highlight several important relationships indubitably involved. The possibility of substitution between factors, as represented by σ, influences the demand for factors when relative input prices change. Pen calls it a one variable summary of the entrepreneur's substitution option (Pen 1971 p. 83). It also affects the ability of factor owners to force higher wages. Elasticities of demand (both income and price) are also important, influencing output effects of change and the direction of relative price changes. The bias of technical change, as well as the form of that change is clearly vital to consider.

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These conceptualizations alone are enough to begin to understand some problems. Even if productivity change has occurred at equal rates in agricultural and non-agricultural sectors, for example, the relative inelasticity of both income and price elasticities of demand for agricultural products means that the relative price of agriculture-intensive inputs will fall while non-agriculture-intensive inputs will rise. Agricultural income falls relative to nonagricultural income even though there may be an absolute income gain. This is the relative decline of agriculture which occurs in developed economies.

Even though the distributive consequences suggested by the one-sector and two-sector models differ, and the relative simplicity of the one-sector analysis falls far short of the complexity of most markets (as does the two-sector, as will be discussed in the next section), Binswanger suggests it can be useful in several situations. One circumstance arises when technical change only occurs in some regions, because the cross-sector influences will be less. When unemployment is large or the inability of resources to move between regions or sectors takes time, the one-sector conceptions can be more appropriate in the short run than the two-sector (Binswanger 1980 p. 266-267).

It should be noted that these models have assumed an inelastic supply of inputs, even though input supply is obviously important. Marginal Productivity is a theory of input

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input demand, not of supply. In real situations input prices do affect the quantity of inputs supplied. If such a possibility is added to the models, elastic input supplies reduce the size of the factor price effect but increase employment.

b. Returns to Research

The production function based returns to research approach is an approach similar to Marginal Productivity Theory differing only by explicitly estimating the contribution of research to change. At its simplest, this is done by including the level of expenditures on agricultural research as one factor in the production function. Variation arises in the complexity of the imposed (through the function) mathematical relationship between factors (Cobb-Douglas, Leontief, or Translog functions, for example). The resulting estimated functions are not only used to draw conclusions about returns to research, but also the biases of change, p

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provide indices of productivity growth, and even test the Induced Innovation Hypothesis.[13]

4. Limitations (What These Do Not Say)

This is the most important question to ponder about Marginal Productivity and production function approaches, because the omissions are clearly relevant for income distribution and for accuracy of the results of analysis. The world presented by them is overly simple and straightforward, devoid of the dynamic interactions of political power, economic power, and the plethora of other interdependencies, much less market failure. The predictions are based on simple deductive models, not on direct observation of how the world really operates.

Even though substitution, demand, and bias of change are useful, they do not go far enough. They do not explain what

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[13]See Griliches (1964) on returns to general agricultural research; Peterson (1967) on returns to poultry research; Bredahl and Peterson (1976) on returns to cash grains, poultry, dairy, and livestock research; Knutson and Tweeten (1979), and White and Havlicek (1982) on potential returns to present and future research expenditures; Stranahan and Shonkwiler (1986) on returns to research by citrus-producers in Florida; Lianos (1971), Binswanger (1974), Lopez (1980), Stevenson (1980), Chambers (1982), Ray (1982), and Antle (1984) biases of technical change and the structure of agriculture; Nadiri (1970), Langham and Ahmad (1983), Ball (1985), Capalbo and Denny (1986), and Evenson (1987) on derived productivity indexes; Lopez (1980), Stevenson (1980), Antle (1984), and Kawagoe, Otsuka, and Hayami (1986) gave at least passing attention to testing the Induced Innovation Hypothesis; and Perrin and Winkelman (1976) and Hall and LeVeen (1978) looked at economies of scale and technical change in agriculture.

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influences the level of substitution possible, the choice of the direction of change, or even what "creates" the production function, all important to final performance. The dynamics of change are similarly neglected, in part because the theory of change arising from them is equi-static. These and other omissions will be examined in two parts: at the level of the theory (given the assumptions); and of the levels of the theory (about the assumptions and theoretical focus).

a. Given the Assumptions

Marginal Productivity Theory suffers from applicability problems because it only applies to limited cases: because it says nothing about supply, it is only a factor demand theory. Supply must be taken as fixed, or the theory cannot estimate returns. Even with fixed supply, clear answers about relative price changes disappear as soon as more than two sectors or factors are considered (Binswanger 1980 p. 259). This is troublesome because at least three income categories are required in actuality; "profits keep spoiling the two-factor game" (Pen 1971 p. 193).

If the ownership of productive factors is separate from the claim on returns, as modern versions of Marginal Productivity Theory state, it does little to relate the size of factor returns to exactly who receives returns from production, precisely what a distribution theory should do. Furthermore, Marginal Productivity Theory is based upon the income

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income it is trying to illuminate. Product demand curves are "drawn up on the basis of fixed money incomes," requiring the level of income to be taken as a datum (Blaug 1986 p. 438).

The strict market-clearing assumptions inherent in the theory severely limit usefulness, because they eliminate some of the market level sources of income which arise from productivity change. Only "private" goods are considered, eliminating externalities. Market failure is not possible. Short run profits are not considered (long run profits similarly suffer inattention), even though they often provide the incentives for innovation and change.

Displacement costs arising from change are ignored by the market clearing assumptions (displacement does not occur in such a world), even though short run displacement costs can provide enough resistance to halt or slow change (Schmitz 1980). Such consideration should include search and relocation costs as well as the possibilities for finding alternative employment. Immobility and reemployment are relevant for factors besides labor: machinery, land, buildings in agriculture all suffer from various levels of immobility.

Under the perfect competition model of the theory, "surplus" profits in the long run equal zero; "normal" profits as described above are occasionally considered costs, "because these are said to be necessary to keep entrepreneurs at their work." But how to separate these "normal" profits from surplus profits is not always clear in the theory (Pen 1971

p. 130). "Abnormal" profits are not unequivocally discernable. Explaining long run profits is especially important for analyzing income in agriculture. "A person who works on his own account," like a farmer, "does not receive any wage income... professionals of this kind receive total proceeds, deduct the costs incurred and what remains is, economically speaking, profit" (Pen 1971 p. 131).

Because the size of the firm is irrelevant under perfect competition,[14] distribution between factor owners is not examined, even though firm size is important in productivity change through determining who has the resources to adopt a new technique and find alternatives, and who is displaced. Volume differences influence income, even without including scale biases in change. Scale biased productivity change, important in agriculture, are unanalyzable without being able to recognize firm sizes.

These market-clearing assumptions eliminate three of the things Pen says influences factor demand, which thus help determine the level of market determined income. These include the profit in the industry (higher wages can be paid by reducing profit instead of decreasing other factor prices or raising output price), the ratio of the factor in the price of the end product (provided the elasticity of demand is

[14]Assumed away by the constant returns to scale.

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greater than the elasticity of substitution)[15] and social connections between factor prices (if wages move hand in hand) (Pen 1971 p. 91-92).

The view of the market place is rather limited, merely consisting of consumers and producers. Behaviors are simply production, consumption, and sometimes a choice between production methods. Government plays no role here, even though it is actively involved in agriculture and an important influence on agricultural income. The multi-level dimensions of modern agricultural markets, ripe with the organizational complexities of input production, production, transport and handling, processing, wholesaling, and retailing, and the necessary coordination mechanisms involved, are a far step from this simplicity. The theory could be applied to these levels without resorting to power by either limiting analysis to one layer of the puzzle (i.e. farm level production, or processing), or by appealing to strict market-clearing assumptions. Either approach loses the diversity and complexity involved, as well as the vital differences between industries.

b. On Relaxing the Assumptions

As mentioned previously, production functions are based on assumed solved problems, as are the perfectly competitive

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[15]If high, factor price increases will have greater effect than if the ratio is low.

market conditions, receiving definition only in the context of previous choices about market institutions. The analysis is specific to how input prices and quantities sort themselves out after technical and market institution decisions have been made, not on how these decisions are made. But the determinants of income distribution often occur _within_ the decisions between the technical relationships reflected by production functions, and within the selection between markets, not just afterwards as Marginal Productivity analysis implies.

In this regard these analyze income distribution or returns by sifting out the "efficient" conclusion given status quo technical relationships, market rules, and claims on income, not what determines which technical relationships, rules, and claims to income (and definition of efficiency) will be regnant even though these create the opportunities and payoffs Marginal Productivity analysis purports to predict. They thus begin analysis at a point after many of the decisions affecting income distribution have already been made.

Productivity change occurs outside of the Neoclassical paradigm, influencing (and influenced by) claims on production, scarcity, and relative endowments. It is part of the choice _of_ markets, not just _in_ markets as these assume. The theory allows predicting what will occur once a change has been specified (either as a production shift or change of input quality), but not of how, why, or precisely where such changes occur. Neoclassical approaches are meant to be predictive, not explanatory. Some of the ignored choices _of_ markets are especially pertinent to understanding the kind of change which occurs: the determination of "relevant" inputs and output; the origin of claims on output; choice of technology and direction of change; and creation and change of preferences.

Production functions only note a few of the essential contributions to production, taking lots of other contributions which affect productivity for granted, among them: the air or water used to dispose of wastes; the collective action which creates property rights (Kearl 1977); the knowledge which helped specify the technical relationships; the enforcement agreements (whether followed by everyone willingly or through coercion) which guarantee that each input unit purchased as an "A" actually _is_ an "A" and not a "D"; the institutional arrangements which allow these elements to be exchanged (and owned) and the manner of their so doing. What they note is a function of rights, not a mere physical relationship separate from this context.

The inputs or outputs of the function are those endorsed by the status quo property rights, not necessarily all of those involved in production. Part of the process involved with productivity change is to alter these property rights to either force entrepreneurs to consider these factors in their decisions, or to help them avoid this responsibility. Debates over industrial accidents,[16] undocumented workers, and nonpoint pollution, for example, are of this nature, attempting to decide whose claims will be regnant.

Avoiding these property rights questions by simply appealing to the status quo rights not only prevents observing how changes in rights influences productivity (and vice versa), but also begs the question of how or what determines which claims on production are recognized, the very matter which is central to distribution processes and therefore should be at the center of analysis. Such appeals say that people get the income they do simply because "that's the way it is." "Ownership" is not enough of an answer without clearly specifying what rights are involved, or without considering other claims to income.[17] Analysis cannot deal with everything at once, so simplifying assumptions are necessary. Making these assumptions about property rights and entitlements, however, assumes away the problem and solutions.

Besides the question of recognizing contributions, Marginal Productivity Theory has problems because it does not clearly separate productivity and income, the two chief elements involved. When productivity is viewed in value

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[16]Does the worker carry the risk of accident, or does the entrepreneur via worker's compensation laws?

[17]Marglin, for example, says that the distinction between claims on profit, ownership of capital, and control of production must be made (1984 p. 326).

terms, as in Marginal Productivity analysis, divining between productivity and income is difficult, leading to confusion between the two. The theory "is circular in that it lacks an independent confirmation for its assertions. It argues that greater productivity will receive more income, and that the evidence for greater productivity is that larger income is received" (Samuels 1982b p.8).

The choice between productivity changes (whether new technology, organization, or skill) is also important because it has clear effects on the distribution. Induced Innovation Theory recognizes the importance of this, suggesting the decision is based on relative prices. But this is not a wholly satisfactory answer because other social influences are obviously involved (sometimes reflected via relative prices, other times not). The resources and power of actors are important in determining whether change can occur, and the form of that change.

The distribution of income is clearly influenced by other factors not expressly in Marginal Productivity Theory, including the vital issues of compensation, transfers, social conventions, and the immobility of assets. The subject of compensation includes several aspects which bear on income. The ability to demand compensation for change which was damaging is obviously important, influencing the rate of change as well as income. This ability includes the complex problem of determining who was damaged (and by whom), as well as the power to compel (or avoid) payment. Related to this is the question of who must pay the compensation. Those judged to cause the damage are not necessarily those responsible for paying the compensation, and vice versa. Determining the size of compensation due is also important, as is discerning how the payment or nonpayment of compensation influences the direction and pace of change (and thus of the size and distribution of income).

Pen (1971) argues that many returns are not derived from the interaction of supply and demand, but instead from direct choice. These include deficiency payments, the wages of school teachers, military officers, and others whose income is not directly tied to supply and demand. Transfers to farmers and others are similarly determined by the political process. These incomes may reflect social norms instead of imputed productive contributions. Social status can be more important than Marginal Productivity for income (Pen 1971 p. 39). Social conventions, or wage contours, also influence the level of remuneration, as does inequality of opportunity (Pen 1971 p. 40; Thurow 1984). With the relatively large government role in agriculture, these sources of income are important determinants of agricultural income.

D. Qualitative Approaches

There are other approaches to productivity change and income worth considering, which will be called qualitative approaches for want of a better term. These include concern with the rates and disparities of adoption (the Treadmill), and appropriation (through bargaining, power, or other means) of benefits.[18] These tend to be more institutionally oriented, and do not limit themselves to mere production or consumption choices within a fixed context.

1. The Treadmill (Adoption)

Treadmill Theory, most often associated with Cochrane, attempts to explain the increasing growth in farm size and the process of change by comparing the short run incentives for adoption of technology with the long run consequences. The crucial elements are speed (and ability) of adoption, and ownership of land.

At its simplest, as Cochrane described it (1979 p. 387-390), when the "early-bird" farmer adopts a productivity increasing technology or practice which reduces per unit costs, he increases output and earns a profit on that output (with a competitive market, the change in his output has no effect on market prices).

As other farmers adopt the new innovation, total market supply increases and prices fall, reducing the rents earned by early adopters. When "Mr. Average Farmer" finally adopts the innovation, market prices will have fallen to the new

[18]This does not refer to Marxist Appropriation Theory.

long-run equilibrium where price equals the new marginal cost, in which farmers receive no profit and no loss. Profits earned by early adopters are wiped out by price changes stemming from everyone elses' adoption of that innovation.

The winners from productivity change here are the early adopters, who earn short run profits until everyone else follows their lead, and consumers, who in the long run receive the same product at a lower price. The losers are those farmers who do not adopt the innovation, and thus are left with uncompetitive production techniques.

> To sum up, the aggressive, innovative farmer is on a treadmill with regard to the adoption of new and improved technologies on his farm. As he rushes to adopt a new and improved technology when it first becomes available, he at first reaps a gain. But, as others after him run to adopt the technology, the treadmill speeds up and grinds out an increased supply of the product. The increased supply of the product drives the price of the product down to where the early adopter and all his fellow adopters are back in a no-profit situation. Farm technological advance in a free market situation forces the participants to run on a treadmill.
>
> (Cochrane 1979 p. 389)

Government programs providing price stability to agriculture exacerbated this by creating a stable situation in which the "alert and aggressive farmers" could invest in new technologies and farm lenders were willing to "assume the risk of making farm production loans" (Cochrane 1981 p. 373).

This meant that "the alert and strong cannibalized the less adaptable and the weak" (1981 p. 366). Land is the limiting factor in agriculture, so the competition to expand and capture the benefits of change drives up land prices. The expected benefits from change "thus vanish" into the price of land (Herdt and Cochrane 1966 p. 262). The big gainers are land owners, who see the benefits of innovation and government programs capitalized into their assets.

This is a useful conceptualization of the process of change, because it offers a short run explanation of the importance of the timeliness of adoption, the choices facing farmers, the influence of government programs, and the observed rise in land prices. It is clear that adoption is a vital influence, at least in the short run, for who benefits from change.

The Treadmill is restrictive, however, because it relies upon a competitive model of markets. The institutional depth of the analysis is thus shallow, and predictions are premised on simplistic conceptualizations of market operation and behavior. It is clear that adopters can sometimes reap long run gains and that consumers are not always the only beneficiaries, contrary to the theory. The Treadmill is important to keep in mind, but is not enough in itself to explain entitlements and productivity.

2. Appropriation

Other models have attempted to look at how benefits are divided between the interested parties, eschewing competition assumptions with direct concern for relative bargaining strengths, power, and other institutional elements of markets. These approaches are dissimilar in many ways, sharing only an emphasis on human relationships, and reflecting the lack of a predominant theory to which all subscribe. The diversity is worth exploring.

Gotsch (1972) created a conceptual framework oriented towards agricultural development in developing countries, asserting that to see the distributive effects of change one needs to explicitly relate the characteristics of the technology with the social and political institutions present. He suggested four major categories of analysis: the characteristics of the technology (including efficiency, and the effect on factor intensities), the absolute magnitude and relative distribution of productive assets (especially land), the types of institutions and organizations that exist at the local level and the distribution of their services, and social customs and traditions. Three feedback mechanisms make this a dynamic framework: capital accumulation, the influence of the change in income and power on the institutions, and the effect on social and cultural traditions.

This was applied to a case study comparing the distributive consequences of tubewells in Pakistan and

Bangladesh, two countries with different institutions and customs. In both regions the tubewell technology was virtually identical, but the different tenure relationships and institutions created widely different distributive consequences. Ownership patterns in Pakistan allowed individual farmers to adopt the wells, because large farmers had sufficient acreage, resources, and the availability of subsidized credit. Small farmers had access problems, and were unable to adopt or to purchase much water from adopting neighbors (who became monopolist suppliers of water because of the location specific nature of the wells). As long as tubewells were unavailable to small farmers, they could "be a source of increasing income inequity in Pakistan" (p. 335). The factionalism in Pakistan would probably limit organizing agricultural institutions to assist smaller farmers.

In Bangladesh, per farm acreage was much smaller, making it harder for farmers individually to adopt the wells. Cooperatives were formed to allow collective adoption, increasing smaller farmer access compared to Pakistan. Nearly all farmers, regardless of size, benefited absolutely from the tubewells, though membership in a cooperative was important. The influence of the tubewells on existing institutions was positive, having been a "powerful instrument in solidifying the community organizing activities" (p. 338).

This was a useful study because it clearly illustrates how institutions influence the distribution, and that the "nature of the technology" is not as all important as often alleged. The examination of the institutions was limited, however, despite their recognition. More depth is required, to offer greater explanatory power of the distributive mechanisms.

Another approach was attempted by Hill (1966), who tried to explicitly include relative bargaining power in predicting the distribution of joint profits under conditions of less than perfect competition. Using marginal analysis and isoprofit curves, Hill posited that the absolute limits of the bargaining range "are established by the minimum profits acceptable to the firms engaged in negotiation" (p. 75). The equilibrium within this range is determined by the relative bargaining power of the participants. He illustrated this with the distributive consequences from a productivity change in Michigan asparagus processing.

This was a worthwhile effort to include the role of power differences in influencing distribution, but because of its strong Neoclassical base did not have the flexibility to explore power more completely. The model serves more as an example that bargaining can be important than as a complete tool for applications.

Ezekiel (1957) similarly investigated how gains have been distributed, focusing more specifically on empirical evidence.

He suggested the gains from productivity increases can be distributed in several ways besides the typically considered decreases in consumer prices. These include: 1) increased leisure for workers in the innovating industry; 2) increased real income per week for workers in that industry; 3) "in changing payments for inputs of goods and services obtained from other industries"; 4) increased payments to owners of capital in the industry; or 5) reduced real prices for the industry's products, benefiting those in other industries and occupations (p. 363).

Gross empirical evidence of these were examined in a variety of industries, including steel, other manufacturing industries, and agriculture. Productivity indices, real wages, hours in a worker's work week, deflated prices, purchases of products and services as a percent of sales, and profits over time were evaluated, providing an indication of how changes were apportioned between the five possibilities. With agriculture, for example, he concluded that increased productivity went slightly into more leisure by farmers, "substantially into increased real incomes of farmers and farm workers" and "partly into reduced real prices to consumers" (p. 370).

Obviously, these are rough estimates because the data he used omits a lot of relevant information, including changes in product quantity, number of workers, amount of capital involved, and the definition of markets, as well as is a more macroeconomic, long run perspective. The distribution of benefits from an individual innovation are not readily traceable from this approach because the general nature of his data can as easily reflect other short run influences as the productivity change. The factors influencing which workers and firms survive are also not discernable because of the gross aggregations. But the five possibilities for distribution of benefits is useful to keep in mind.

The final study considered here is American Shoemakers by Commons (1909). He traced the development of American shoemaking through five stages, from its craft gild origins in 1648 to its industrialization in the late 19th century, with an emphasis on how the human relationships changed and were reflected in market rules and organizations, affecting the kinds of productivity change occurring as well as the distribution of benefits from those changes.

The first four occurred without changes in the tools of production, but only through change in markets.

> ...the ever-widening market from the custom-order stage, through the retail-ship and wholesale-order to the wholesale-speculative stage, remove(d) the journeyman more and more from his market, divert(ed) attention to price rather than quality and shift(ed) the advantage in the series of bargains from the journeyman to the consumers and their intermediaries.
>
> (p. 67)

His emphasis on how the choices about markets influenced the distribution of benefits included an explicit concern with the organization of actors, their rights, obligations and relative bargaining strengths, and the opportunities available to each under the market rules. Market exchange occurred within this context only after the institutional issues were resolved, because the latter gave definition to the former.

Understanding this diversity of approaches, as well as the unavoidable influence on results that occurs when an approach is selected, requires more than review of their theoretical underpinnings. It would be useful to compare how the different approaches analyze a case study. This would also highlight the inevitable analytical choices necessary to study productivity change and income.

Chapter 3

The Difficulties of Bringing All of This Together

A good illustration of the differences between these approaches, as well as the general difficulties of analyzing productivity change and income distribution, is the plethora of studies about the mechanical tomato harvester. The mechanical harvester is one of the most studied cases of technological change in recent agricultural history: it produced a major law suit against the University of California, proclamations from the U.S. Secretary of Agriculture, major reevaluations of the role of public research, an unprecedented adoption rate, significant changes in the structure of canning tomato production, as well as various distributive analyses. The range of these analyses, all focused primarily upon the mechanical tomato harvester, allow interesting comparisons between methodological styles and assumptions. They also help illustrate the empirical difficulties of analyzing change, and the influential role of assumptions and value judgments in final results.

A brief history of the harvester will be presented, followed by a review of each evaluative study. The distributive consequences estimated by each study will be highlighted and compared, before focusing on the influence of analytical approach on these disparate results. The purpose is not to disprove any one study, but to use the variety of analyses to illustrate the necessary but influential choices involved in analyzing change. Implications of the role methodological and theoretical choices play will be drawn, as well as other lessons relevant for analyzing the consequences of change. This background will be used to explore the general empirical difficulties associated with income and change, as well as other problems. Finally, where these theoretical and empirical limitations leave us will be briefly explored.

A. Evaluating the Mechanical Tomato Harvester

1. Brief History of the Mechanical Tomato Harvester[1]

Processing tomatoes are a valuable crop, originally produced in many states. In 1960 over ten states produced at least 100,000 tons annually. California had always been an important producer among these states, with 55.5 percent of national production in 1960. That share had increased to over 84 percent in 1983, in large part due to the adoption of the mechanical harvester (Friedland & Barton 1975).

Canning tomatoes are perishable, susceptible to loss if not harvested or processed promptly. Harvest must be timely,

[1]This general background has been summarized from the information in Rasmussen (1968); Friedland and Barton (1975); de Janvry, LeVeen and Runsten (1980); and Feller, et al (1984). These should be consulted for a more specific historical account.

and they cannot be subjected to rough handling. Traditional production in California rested on forward contracts between processors and growers, agreeing to acreage and delivery before planting. Harvest relied upon low cost migrant workers, who would pick a field several times to collect the uneven ripening crop. The availability of harvest labor was crucial. A special program was created by the Federal government to help insure adequate supplies of workers were available for the harvest of different commodities, including canning tomatoes. Called the Bracero Program, it allowed foreign agricultural workers to enter the United States temporarily provided they had guaranteed employment. A significant portion of tomato harvest labor were Bracero workers.

There were relatively few specialized canning tomato producers before adoption of the mechanical harvester: most growers planted tomatoes as part of a diversified crop. This allowed them to adjust production to suit expectations of the market, and spread labor requirements more evenly through the year. Lack of specialization meant there were many growers (and potential growers). Attempts at organizing collective bargaining with the processors had been relatively unsuccessful, in part because of the large number of growers.

The development of the mechanical tomato harvester began during World War II, a time of harvest labor shortages and high prices. G.C. Hanna, a horticulturist at the University of California at Davis, began searching for the right tomato plant for mechanization, believing a mechanical harvester would help with labor problems. The tomato had to be unlike previous varieties: strong enough to not bruise or split with machine picking, be easily separated from its vines, and have all fruits ripen simultaneously to avoid waste (a machine would destroy the vines, allowing only one picking per field).

In the late 1940's, with a suitable tomato discovered, Hanna teamed up with Coby Lorenzen, an agricultural engineer also at the University of California at Davis. The machine was designed by function: cutting the vines, separating the fruit from the vines, disposal of the vines, sorting, and transportation. Refinement of the tomato continued. Growers generally were uninterested in these developments, because labor supplies were more than sufficient after World War II.

A prototype of the machine was field tested in 1959, the same year it was patented by the University and then licensed to the Blackwelder Manufacturing Company. Other universities, including Michigan State University and the University of Florida, and other commercial firms were also working on mechanical harvesters at this time. UC-Blackwelder harvesters were first used commercially in 1961. Acceptance and adoption by growers was slow.

There were several crucial problems involved with the mechanical harvesters. The potential speed of harvest mandated new handling systems between field and processor.

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Sixty pound lug boxes, the previous method, were infeasible because the harvest machines filled them too quickly. Bulk bins of 500 to 1,000 pound capacity, designed to be towed alongside the harvester, were developed as an alternative but required major changes in grower equipment, processor handling, and the sampling methods required for grading.

Mechanical harvesting necessitated a higher level of care and precision during the cultivation of tomatoes. Beds had to be even, planting had to be done in straight rows, thinning had to be more accurate, and application of fertilizers and irrigation water had to be carefully coordinated to insure even set and ripening of fruit. The machines could not operate in wet fields, which was not a problem to California growers if they irrigated properly because it usually does not rain during the harvest season. Growers in other states, however, where it frequently rains during harvest time, found the harvester relatively unsuited for their climatic conditions.

The sorting of tomatoes also proved a problem. During hand harvesting the pickers select ripe tomatoes, explicitly sorting unripe or spoiled tomatoes out from the desired crop. The mechanical harvester, however, would pick tomatoes without regard for ripeness or spoilage. Early models of the machine thus carried 10-28 hand sorters, whose sole task was to watch conveyer belts of passing fruit and discard the unwanted refuse. Alternative sorting arrangements, including bulk

Table 3.1 Percent of California Tomato Crop Machine Harvested

Year	Harvested by Machine	Number of Harvesters	Sale of Harvesters
1960	0.0	N.A.	1
1961	0.5	25	25
1962	1.3	25	5
1963	1.3	30	6
1964	3.5	75	44
1965	20.0	250	158
1966	70.0	800	512
1967	80.0	1000	329
1968	92.0	1300	406
1969	98.0	N.A.	49
1970	100.0	N.A.	5

Source: de Janvry, LeVeen & Runsten (1980) p. 110

sorting at a central location, were briefly tried but were rejected. Electronic eyes, which could differentiate between colors, were developed but not perfected until the mid-1970's.

As political rumblings during 1963 and early 1964 that the Bracero Program might end became stronger, grower interest in the harvester began in earnest. Growers felt threatened that harvest labor would disappear, and that labor costs would skyrocket. There was fear that the canning tomato industry would have to move to Mexico in response to the higher costs, as the white asparagus industry eventually did.

In 1964 the Bracero Program ended, and union organizing activity among farm laborers increased. Growers adopted the harvester at an unprecedented rate. Mechanically harvested tomatoes leapt from only 3.5 percent of total production in 1964 to 100 percent by 1970. Harvest labor requirements dropped significantly as a result, and the type of labor hired shifted significantly away from single, migrant men towards migrant women and local residents. The number of tomato farmers decreased, and average size of canning tomato farm swelled.

Refinements in harvesters continued, increasing capacity (and the minimum acreage required to be feasible). In 1976 the Blackwelder Manufacturing Company introduced a tomato harvester with electronic sorters, substantially increasing the cost of the machine and reducing the number of manual sorters from 14-16 down to 7 or 8. Current machines can operate with even fewer workers.

2. Review of Tomato Harvester Case Studies

a. Schmitz and Seckler (1970)[2]

Schmitz and Seckler used cost savings from the harvester as a measure of the benefits. Distributive considerations were relatively simple: workers displaced by the harvester

[2]Schmitz, Andrew, and David Seckler. (1970). "Mechanized Agriculture and Social Welfare: The Case of the Tomato Harvester." American Journal of Agricultural Economics. Vol. 52:4 (Nov). Pp. 569-77.

were directly taken into account, but growers, processors, consumers, machinery manufacturers, and others were lumped together as "society." The size of benefits available was calculated and assumed to go to "society," without regard for their distribution.

Schmitz and Seckler's approach falls between Economic Surplus and Marginal Productivity. Gross social returns, the total benefits, were estimated by calculating the total cost reduction yielded by the harvester (total production times cost savings per ton), instead of relying upon "unsuccessful" estimates of price elasticities. Economic Surplus would have been overestimated, they claimed, if supply were perfectly elastic, while it would have been underestimated if supply were not.

Research and development costs associated with the harvester were obtained from the University of California at Davis and the Blackwelder Manufacturing Company, and were guessed for the other universities and companies involved. These were divided from the gross social return to calculate a gross social rate of return of 929 percent.

Net social returns were defined as gross social returns (benefits) minus the costs (wages foregone by displaced workers). Alluding to the difficulty of tracing displaced workers and thus discerning the actual value of foregone wages, Schmitz and Seckler looked at different reemployment possibilities, ranging from no displaced worker finding alternative employment to all finding jobs. Wages foregone were the only costs of change considered relevant. When calculated and considering all the scenarios, the net social rate of return was positive in all cases but one, implying that "society" had been made better off by the harvester.

Schmitz and Seckler discussed compensation of workers for their losses, but noted that this had not been done because workers were not organized. This was compared to the powerfully organized International Longshoremen's and Warehousemen's Union which had been able to compel compensation for damages from technological change. The migrant workers' inability to organize and demand compensation meant that they were not able to receive remuneration for their costs. As an answer to this inequity, Schmitz and Seckler concluded that some method to compensate losers be created, perhaps in the form of a tax on output, so that "everyone" would be better off with technological change.

b. Friedland and Barton (1975)[3]

Friedland and Barton concentrated upon the social effects of the harvester, describing the role of and influence on different actors. The process of development was reviewed, including a clear discussion of all the different changes in

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[3]Friedland, William H. and Amy Barton. (1975). Destalking the Wily Tomato. Santa Cruz: University of California. Research Monograph No. 15.

cultivation, transportation, genetics, and mechanics required. How the machines worked, as well as the labor requirements (specific tasks involved), was used as an introduction to an assessment of how adoption affected processors, growers, laborers, and others. This included examination of how processing tomatoes were forward contracted to processors before planting time, the changing role of the California Tomato Growers Association, and the identity and recruitment of harvest crews.

The focus was on individuals and the groups they belonged to, but clearly within a social organization context. The constraints on and interactions of groups were important explanations for productivity change, not mere colorful backgrounds or implied inefficiencies. Effects of the harvester were described, for example, by how the harvester affected the growers' positions relative to each other, processors, and labor.

The social consequences of the harvester, Friedland and Barton conclude, were sixfold:

1) Higher concentration of production of processing tomatoes in the state of California
2) Fewer, larger growers, and increased specialization
3) Geographical shift of production within California
4) Development of price bargaining for tomato growers
5) Sharp changes in the structure of harvest labor force

6) Introduction of factory-like production while still maintaining primitive employment relationships

c. Kumar, Chancellor and Garrett (1978)[4]

Kumar, Chancellor and Garrett focused on in-field labor requirements for tomatoes and other important California crops, projecting the need for six years (1976-1981). The study was meant specifically to consider how mechanization of California crops would affect in-field labor, and so avoided discussing grower, processor, consumer, or other concerns. Welfare implications for labor were derived from predicting how demand for their labor would change.

Data was collected from extension and industry specialists, and was used to project labor requirements under two slightly different assumptions: that acreage and yields would remain at 1976 levels; and that acreage and yields would continue increasing. The data consisted of four major categories of information: 1) the degree of mechanization in the crop; 2) the estimated degree of mechanization in five years; 3) man-hours of in-field labor required per acre for unmechanized production; and 4) man- hours of in-field labor required per acre for mechanized production. Cultivation,

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[4]Kumar, Ramesh, William Chancellor, and Roger Garrett. (1978). "Estimates of the Impact of Agricultural Mechanization Developments on In-Field Labor Requirements for California Crops." Technological Change, Farm Mechanization and Agricultural Employment. University of California Research Monograph No. 4085. Pp. 157-98.

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irrigation, and planting, as well as harvest labor, were considered.

The adoption of the electronic tomato sorter (not yet fully operational at this time) was predicted to reduce harvest crew need from 27 man-hours an acre with hand sorting to 16 man-hours an acre. The adoption was not expected to be universal, however, reducing the potential loss of jobs. Average in-field labor requirements for canning tomatoes, including all functions, was expected to drop from 53.9 hours an acre to 47.5 hours an acre.

The major change on in-field labor was predicted to be a regional effect of reduced in-field opportunities in some localities and increased opportunities in others. This would impact directly upon locally resident farm workers, and destroy some formerly effective migration patterns. It was these impacts which appeared to be the authors' major concerns, rather than large reductions in total in-field work requirements.

d. De Janvry, LeVeen and Runsten (1980)[5]

The political economic analysis by de Janvry, LeVeen and Runsten was based on three levels of analysis: social class structure, economic structure, and matrix of expected payoffs.

[5]De Janvry, Alain, Philip LeVeen and David Runsten. (1980). Mechanization in California Agriculture: The Case of Canning Tomatoes. Berkeley: University of California.

The approach saw the tomato harvester as a response to social conflict, so consequently knowing the context of its creation was vital. This included the political and historical circumstances involved. They did not quantify their assertions with derived numbers, but instead used historical events and observed information to substantiate their claims.

The analysis began with the historical background of Californian agriculture, including the nature of landholding, availability of cheap labor, and the influence and exercise of state power in these. Californian growers, they claimed, historically survived by keeping labor costs extremely low. California was far from major commercial markets and faced high transportation costs. To exist, costs had to be low. Immigrants, who were not yet part of American society and thus were easier to control, were brought into the U.S. to work in the fields. Chinese immigrants were the first important workers, followed by Japanese laborers, and finally by Mexican workers. The State was an instrument of grower desires, creating laws to keep immigrants from owning land, leaving agricultural workers out of legislation allowing labor organizations, creating the Bracero Program expressly to help growers, and using state power to discourage union activity.

The history of tomato mechanization was then examined in relation to political events (e.g. rights to bargain collectively were given to agricultural labor the same year electronic sorters went on the market) and from a perspective

Table 3.2 Winners and Losers from the Mechanical Harvester

Group	Payoff from Harvester
Consumers	(+ -)[2]
Ag Machinery Manufacturers	+
Banks	+
Seed Companies	+
Land Owners	+
Large Growers	+
Small Growers	-
Seasonal Workers	(?)[3]
Industrial Workers	+
Processors	(+)[4]

notes:

2 At best a small benefit: may have lost if the industry stayed in the U.S. instead of moving to Mexico.

3 Seasonal workers would have lost their jobs anyway, if the industry had moved to Mexico.

4 Small benefits, except for those with high fixed investments in the United States who would have lost if the industry had moved, who greatly benefited.

of alternatives. The authors paid particular attention to the "what would have happened," to show that the choice of mechanization flowed from this social conflict and not from the influence of relative prices. Five alternative responses to the end of the Bracero Program, actually occurring in other commodities from this same stimulus, were presented to illustrate that non-mechanization solutions were possible. One very likely possibility was that production would have shifted to Mexico, yielding even lower retail prices than arose with mechanization. The choice of direction between these alternatives was a result of social structures and power, it was said, not mere concern with factor prices. De Janvry, LeVeen and Runsten concluded the adoption of the mechanical tomato harvester could only be understood as the outcome of a social conflict between capital and labor.

Payoffs of the adoption were then examined, including the structural changes in the canning tomato industry, how the relative power of various groups was altered, and whose opportunities had increased or decreased. The list of relevant actors was much longer than in other studies, including machinery manufacturers, banks, and seed companies.

e. Just and Chern (1980)[6]

Just and Chern looked at the processing tomato industry to see if competitive or market power behavior could be gleaned from empirical analysis when cost or profit information cannot be measured directly. They posited that the direction of movement of price and quantities in response to grower adoption of mechanical tomato harvesters could signal the presence of processor market power: if processors were competitive, the price-quantity relationship would remain

[6]Just, Richard E. and Wen S. Chern. (1980). "Tomatoes, Technology, and Oligopsony." The Bell Journal of Economics. Vol. 11:2 (Autumn). Pp. 584-602.

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unaffected; while if processors had market power over demand this relationship would shift. Direct welfare implications were not drawn by the authors, but they are easily deduced from their results and underlying assumptions.

The argument was presented diagrammatically as well as mathematically, based on fixed and variable costs. Directions of expected changes in price and quantity were predicted, given assumptions of competition among growers and under conditions of perfect competition and oligopoly-monopsony on behalf of processors. Under processor competition, supply shifts (from the harvester) would not affect the demand function. If oligopoly- monopsony existed among processors, demand would shift at the same time supply did.

This argument was tested via econometric estimation of supply and demand for processing tomatoes, before and after adoption of the mechanical tomato harvester. Results suggested that supply shifted with the tomato harvester displacing labor, as expected. Demand became more inelastic with adoption of the harvester. Statistical tests rejected competition, in favor of oligopoly-monopsony. It was further suggested that quantity and price movements did not support competitive theory, but behaved exactly as oligopoly-monopsony theory predicted. This evidence was supplemented with testimony from unnamed experts who believed a single processing firm had been the dominant price leader for the past twenty years.

The consequences of this analysis on the distribution of benefits and costs arising from the mechanical tomato harvester are clear from Just and Chern's assumptions and conclusions: processors, with oligopoly-monopsony power, benefited from the adoption of the harvester, because they were able to capture some of the generated surpluses. Growers, by assumption in a purely competitive situation, were unable to capture benefits in the long run, because competition would drive their profits to zero. Large growers, able to take the larger risks associated with the mechanical harvester's higher fixed costs, were able to stay in tomato production, while smaller growers had to quit. Custom harvest could not be relied upon. Processor facilities designed to handle mechanized harvests were unable to accommodate hand harvested tomatoes, eliminating the possibility of marketing tomatoes from unmechanized production (and thus eliminating the smaller growers who could not afford mechanical harvesters). Labor was displaced, but alternative employment possibilities were not explored.

f. Price (1983)[7]

Price used a consumer surplus approach, focusing more specifically upon electronic tomato sorter-equipped

[7]Price, Barry L. (1983). The Political Economy of Mechanization in U.S. Agriculture. U.S.A.: Westview Press, Inc.

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harvesters, but stated clear difficulties with the method. He noted that disaggregating "society," as well as specific groups, is important for discerning distributive impacts, because benefits do not necessarily accrue equally to all. Relative power is important for distribution of costs and benefits. The costs of change cannot easily be quantified, because they induce change in the satisfaction of work as well as cause wage, profit, and employment effects on other commodities.

Price looked at specific actors and their situations, in an effort to see which had sufficient power to usurp benefits, including: farmworkers and their reemployment possibilities; tomato processors and the degree of concentration; tomato growers and their ability to organize, as well as the effect on large and small producers; and consumers. This information was used to help interpret preliminary consumer surplus estimates gleaned from estimates of supply and demand response. Labor displacement costs were calculated by multiplying annual hourly wage by the number of hours of labor an acre displaced and by the average acreage of tomatoes grown in the nine studied counties, and considering alternative reemployment rates.

The technology appeared much less favorable than many of the other studies indicated, Price concluded, given the qualitative factors. Reemployment possibilities were dim, and weighting workers' losses (deemed appropriate because wor

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workers' incomes were much less than the societal average) by only a factor of 1.7 negated any "net social benefit."

Furthermore, both processors and growers had been capable of exercising significant market power in their dealings with other economic actors in the tomato processing industry, raising doubts about how much of the "consumer surplus" would actually reach consumers. It was possible that consumers would receive no benefits and as taxpayers still end up paying for the costs of research and development. Growers, faced with more risk because of higher fixed costs, could no longer protect themselves from wide fluctuations in market price and were in a more vulnerable position than they were before adoption of the harvester. Processors, already in a relatively non-competitive market, were pushed further from a market structure that would "insure that the gains generated... would necessarily be passed on to consumers."

g. Brandt and French (1983)[8]

Consumer surplus measures and simulation analysis were used by Brandt and French to evaluate implications of the mechanical tomato harvester. Saying that appropriate welfare comparisons must be made between "what happened" and "what would have happened," Brandt and French created a dynamic

[8]Brandt, Jon A. and Ben C. French. (1983). "Mechanical Harvesting and the California Tomato Industry: A Simulation Analysis." American Journal of Agricultural Economics. Vol. 65:2 (May). Pp. 265-272.

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econometric study of the processing tomato industry to estimate four possible scenarios of the industry if the mechanical harvester had not been adopted. These scenarios were then used as comparisons with what actually occurred, providing another basis for welfare implications.

The approach was described by the authors as differing from Schmitz and Seckler's, and Just and Chern's analyses in its more completely specified industry model, dynamic adjustment process, wider range of employment effects, and its post mechanization labor supply conditions. The model included three main behavioral relations (a) demand and supply allocation of processed production; b) processor derived demand for raw tomatoes; and c) grower supply, and involved 16 behavioral equations and 40 identities and technical relationships. The model was estimated for crop years 1954/55 to 1977/78.

Mechanized harvest of tomatoes was simulated first, to provide a baseline. The effects of the harvester were then removed, in part by changing grower cost of production series to reflect higher hand harvest costs. Four hypothetical hand harvest cost scenarios were considered: 1) labor was available at the same wage rates experienced with the mechanical harvester; 2) wages increased by 30 percent; 3) wages increased by 60 percent over mechanical harvester wages; and 4) wages increased by 100 percent over mechanical harvester wages. Acreage and producer price changes under the different scenarios were estimated and compared to the mechanical harvester associated acres and prices. Changes in industry labor demand also were estimated, differentiating between specific tasks (preharvest, harvest, assembly, seasonal cannery and off-season cannery labor). This helped estimate the distributive impact of the harvester on labor more clearly.

The estimates indicated total industry employment expanded with adoption of the harvester and the resulting supply response, even though harvest labor declined. However, the results suggested that if hand harvesting had continued, employment would have been even greater under all scenarios. Estimated labor displacement was less than that predicted by Schmitz and Seckler (18,040,000 hours with scenario 1, to 13,550,000 hours with scenario 4, compared with Schmitz and Secklers' 19,477,227 hours). Brandt and French attribute this result to their more explicit account of price effects of output change, among other things.

The social welfare implications of the tomato harvester were then estimated with consumer surplus, using each scenario as the "what would have happened." Consumer surplus was calculated as the area under the processor raw product curve facing growers, and producer surplus as the change in net return per acre times the acres of production. Estimates of 18 year total consumer surplus ranged from $366 million to about $930 million, but the higher estimates were deemed more likely. Similarly, while producer surplus ranged from a negative $61,952 to positive $164,010, the two high estimates (both positive) were considered more reasonable. Consumers were judged to have been the primary long run benefactors of the mechanical harvester. Total industry labor employment was deemed less with the mechanical harvester (harvest labor was 20 percent of total employment under mechanization, while it was 50 percent with hand harvest), but wages were higher and working conditions were judged improved.

h. Feller, et al. (1984)[9]

The Feller, et al. study of the mechanical tomato harvester was part of a larger interdisciplinary study on agricultural technology, which looked at several different technologies having major impact on U.S. agriculture. The overriding objectives of the study were twofold: 1) describe the ways in which formal and informal interaction among a variety of organizations affected the level and rate of adoption of agricultural technology, as well as the impacts; and 2) identify critical issues and problems in the transfer of agricultural technology, and offer policy recommendations.

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[9]Feller, Irwin, Irene Johnston Petrick, Lynne Kaltreider, Patrick Madden, Dan Moore, and Laura Sims. (1984). "Mechanical Tomato Harvester." in their The Agricultural Technology Delivery System: A Study of the Transfer of Agricultural and Food-Related Technologies. Vol. 4. (Dec). University Park: Institute for Policy Research and Evaluation, The Pennsylvania State University. Pp. 4.1-4.73.

The tomato harvester case study involved several dimensions. The historical origins of the harvester were carefully explored, including the roles of university researchers (horticultural and engineering), private companies, and private individuals in its creation and development; early use and refinement of prototypic mechanical harvesters, including the mechanics of the machine, biological adaptation of the plant, new importance of cultural practices, problems in bulk handling and grading, and electronic sorting; adoption and diffusion trends, including effects on production in other states, displacement of labor, and economies of scale; and documentation of the impacts arising from the adoption of the harvester.

The study focused primarily upon the various individuals involved in creating the harvester, describing the difficulties encountered and how these were overcome, not on general social movements or class conflicts. Its perspective of the mechanical tomato harvester posited individual effort working haphazardly, but with growing coordination, surmounting biological, mechanical, and market difficulties. It was thus more a history of the physical technology than of the social circumstances that gave it birth. Explanations were centered on individual responses to incentives and problems, not on how the rules and structure of incentives (or market relationships) were created.

Impacts of the tomato harvester were discussed, particularly with regard to the regional effect (California went from producing 55.5 percent of the U.S. output of canning tomatoes in 1960, to an 84.9 percent share of national output in 1983), aversion of a labor shortage when the Bracero Program was ended in 1964, and the scale requirements necessary for acquisition of a harvester to be feasible. Welfare conclusions from other studies were then reviewed, noting some of the inconsistencies among them. After a brief enunciation of the range of effects, the authors concluded that the mechanical tomato harvester had been a mixed blessing, and that the issue is far from settled.

i. Kim, Schaible, Hamilton and Barney (1987)[10]

Kim, et al. believed that oligopolistic processor behavior had not been adequately dealt with in previous studies, because it would affect the size and distribution of welfare impacts. They reestimated consumer and processor surpluses, using the data from Brandt and French (1983) but with an alternative specification. They then reestimated grower surplus through use of a vertically shifting, kinked

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[10]Kim, C.S., Glenn Schaible, Joel Hamilton, and Kristen Barney. (1987). "Economic Impacts on Consumers, Growers, and Processors Resulting from Mechanical Tomato Harvesting in California-Revised." Journal of Agricultural Economics Research. Vol. 39:2 (Spring). Pp. 39-45.

supply curve. These results were compared to Brandt and Frenchs'.

Just and Cherns' (1980) method of perceiving demand curves, used to test for oligopoly-monopsony, did not yield accurate consumer surplus estimates, according to Kim et al., because the input demand curve under imperfect competition lies below the perfect competition derived demand curve. The area beneath the observed "imperfect" demand curve does not conform to Neoclassical Economic Surplus theory, and thus is not appropriate for measuring consumer surplus. To do so underestimates processor profits and over estimates consumers' surpluses.

The oligopoly-monopsony derived demand curve is all that could be observed, so the competitive curve had to be imputed. This was accomplished through the use of price flexibilities of supply and observed prices. Consumer surplus was measured from under the resulting derived curve, while processor profits were estimated by looking at the monopoly profits implied (the difference between competitively derived demand and oligopoly derived demand, times the quantity).

The Brandt and French consumer benefit estimates appeared inflated by about 25 percent, according to the new estimates, because they were incorrectly based on a competitive model of the raw product market. The new estimates ranged from a low of $297 million to $733 million. Processor profits were between $70 million and $197 million, again depending upon which of Brandt and Frenchs' wage scenarios is considered.

Producer (grower) surplus was estimated with a kinked supply curve and a vertical supply shift. The supply curve was assumed kinked so it would not violate theory by crossing the horizontal axis. The response function from Brandt and French was used in calculating these surpluses, but the new specification of the supply curve and shift yielded estimates substantially larger than those from Brandt and French. Benefits were wholly positive (and incidentally nearly identical to processor profit), ranging from $70 million to $197 million. Welfare impacts on labor were not discussed.

3. Influences Of Analysis

The studies examined here share a focus on the mechanical tomato harvester/sorter, but even within the rough categories they differ in intent, breadth of analysis, and type of explanations. The results can be summarized and compared, as in Table 3.3, but this is a very crude procedure because the studies differ in their time periods, factors considered, definition of actors, size of benefit or loss, and other things.

The studies can roughly be broken into the two arbitrary categories of chapter 2: Neoclassical analyses, based on economic surplus social welfare functions or utilizing various Neoclassical market models; and qualitative analyses, which

Table 3.3 Implications of The Mechanical Tomato Harvester: A Very Rough Comparison of the Results from Different Studies

Author(s) & Year	Method	Agricultural Workers	Processors	Growers — Californian — Large	Growers — Californian — Small	Growers — Other States	Consumers	"Society"
		Who Benefited (+) and Who Lost (-) with Adoption						
Schmitz & Seckler (1970)	Neoclassical (Total, 1965-1973)	(-)	...	...	...	...	...	(+) $199 Mill. to $275 Million
Friedland & Barton (1975)	Qualitative	(-)	(?)	(+)	(-)	...	...	...
Kumar et al. (1978)	Expert Opinion	(+-)	...	...	...	...	...	...
De Janvry et al.[3] (1980)	Qualitative	(-)	(+)[1]	(+)	(-)	...	(+-)[2]	...
Just & Chern (1980)	Neoclass.	(?)	(+)	(0)	(?)	...	...	...
Price (1983)	Economic Surplus & Qualifications	(-)	(+)	=====(+)=====		...	(+-)	(+-)
Brandt & French[4] (1983)	Economic Surplus (Total, 1960-1977)	(+-)	...	=====(+-)==== -$61,952 to $164,010		...	(+) $366,578 to $929,757	(+) $304,626 to $1,093,767
Feller et al. (1984)	Qualitative	...	...	(+)	(-)	(-)	...	(+-)
Kim et al.[4] (1987)	Economic Surplus (Total, 1960-1977)	...	(+) $69,721 to $196,778	=====(+)===== $70,058 to $197,036		...	(+) $296,857 to $732,979	...

[1]Small, except for those with high fixed investments, who avoided asset losses.

[2]At best a small benefit, would be negative if consumers are paying more than if industry had moved to Mexico.

[3]Other effects include: Industrial Workers...(+); Ag Machinery Mfgr...(+); Seed Co....(+); Banks...(+); Landowners...(+)

[4]Possible values are based on four scenarios: 1) Labor is available at same wages as existed with mechanization; 2) Wages are 30 percent higher; 3) Wages are 60 percent higher than under mechanization; and 4) Wages are 100 percent higher than under mechanization. Scenarios three and four, and thus the higher values, seem intuitively more plausible.

more directly consider different kinds of social interaction, avoid explicit social welfare functions, and try to convey results through the use of intragroup (not intergroup) comparisons. The former are deductive, while the latter can be either deductive or inductive.

a. Synopsis

The Neoclassical studies differed in some major ways. The alternative direction of change used as a comparison with the adoption of the mechanical harvester varied between studies, affecting the size of the results. The actual estimation of benefits differed as well. Schmitz and Seckler believed that elasticities were unreliable, so used cost savings times quantity as a measure. Price used elasticities, as did Brandt and French, deriving these from market prices and quantities. Kim et al. also used elasticities, but first converted observed prices and quantities into "what would have occurred with the harvester under perfect competition" before doing so.

Other differences arose with the specification of underlying models (and distribution). Schmitz and Seckler, Price, and Brandt and French used a perfect competition market model, which involved very specific distributive assumptions. Kim et al. used such a model to calculate the size of surpluses, but relied upon an oligopoly model to discuss distribution of these surpluses.

The Neoclassical studies assumed that interpersonal comparisons of welfare were possible, where the benefits and losses accruing to different groups could be expressed in dollar terms. Benefits and losses were expressed in social welfare comparisons based upon surpluses, instead of directly considering the distribution of income. Institutions and distributions of income were assumed by the underlying model (competitive or oligopoly), instead of being directly investigated or explained.

All the Neoclassical studies but Price's weighted different groups' losses and benefits equally in this comparison, assuming that the loss of a dollar income to a wealthy processor was as bad as an equal loss to a poor migrant worker. Group welfares were then compared. If the total value of all benefits exceeded the total value of all losses, the adoption was deemed good. Price noted that if losses of migrants are weighted more, welfare results can be entirely different. Price also relied heavily upon qualitative information in his final analysis of the harvester, not just his consumer surplus estimates.

The qualitative studies differed as well. The "what would have happened" serving as a comparison to events elicited various responses. Because the authors were more hesitant to apply universal social welfare assumptions than Economic Surplus analysts, conclusions did not appear as clear. Evaluations of each group tended to use the concerns of the each specific group under study, instead of imposing one standard on all groups. Results could not be summarized in numbers as the consumer surplus studies had been, but had to be more verbal. These results were thus harder to generalize because they were more specific.

The theoretical choices varied between the qualitative studies. This included the relative emphasis on individual actors or on groups, and the type of causal agents inferred. Friedland and Barton focused relatively equally on individual actors and groups, noting how social and economic factors influenced individual and group incentives. Feller et al. stressed individual actors within groups. The incentives and pressures on individuals were presented as means to explain the changes which occurred. De Janvry, LeVeen and Runsten stressed group actions more heavily, emphasizing union activities and legal changes. They assumed inter-group conflicts were the motivating force behind adoption.

Institutions were considered more directly in the qualitative studies, because they were seen as important influences on the motivations and payoffs to each group. The studies, especially de Janvry, LeVeen and Runsten's, also considered individual and group behaviors explicitly intended to change institutions, and thus market performance.

b. Methodological Differences

Comparison of the mechanical tomato harvester studies illustrates the influence of different methodology, including the choice of explanatory model. The type of model underlying the analysis affects interpretation by suggesting causal relationships and what data is relevant. They determine the hypotheses "worthy" of study. The choice between alternative models has bearing on results, but is a paradigmatic choice beyond the purview of science, depending upon the value judgments of the researcher which adjudicate "appropriateness." Inductive approaches, not dependent upon a deductive model to interpret experience, are dependent on value judgments to do the same.

The Neoclassical studies used distributive models for interpretation, assuming the distributive patterns through choice of model. The models minimize the influence of institutional rules and rights on the resulting distribution. Schmitz and Seckler, and Brandt and French based their analyses on the perfect competition market model. Benefits from the technology were assumed to accrue to consumers because the market place abrogates growers' and processors' abilities to "capture" them. Brandt and French did not consider power, while for Schmitz and Seckler it arose primarily in the ability to demand compensation for damages.

Just and Chern, and Kim et al. believed that tomato markets do not necessarily work like perfect competition models, because processors were able to exercise enough market power to appropriate part of the benefits from the mechanical harvesters. The behavior of processors becomes more important in such a world, as does directly looking at the distribution of benefits. Their approaches to distribution, however, still relied upon assumption of a monopoly model to interpret where imputed benefits had gone, rather than more direct measures of the actual distribution to each group.

The model chosen affected what data was considered relevant to the case and what data was not. The Neoclassical analyses relied primarily upon market prices and quantities, simply differing in the complexity of how they transformed it. Information about market and institutional structure was generally only used to pigeonhole which theoretical model applied. The history of the innovation, including interest groups involved, rules affecting implementation, and incentives faced by different groups were also not very important.

The evaluations of the goodness or badness of the innovation were done with constructed social welfare measures based on one social welfare criterion (Economic Surplus), not with direct observations of the distribution of income or with multiple criteria. Actual distributions of benefits and costs were not considered directly, because the total size of benefits and losses across "society" (however defined) were deemed an appropriate evaluation, even though incidence was ignored.[11]

The qualitative approaches generally tried not to impose deductive interpretation on events, but also saw their method and theoretical choices influence perception of the case by imputing causation and which data was relevant. They looked more closely at the behaviors and numbers of different actors, attempting to explain the innovation from more of a structure of incentives perspective. Changes in rights, rules, and relative opportunities were more apt to be discussed. The incentives for adoption, the number of machines, tasks involved in production, potentials for reemployment, barriers to acquisition of a mechanical harvester, and costs were also discussed beyond mere pecuniary measures. This focus allowed explaining how the distribution was influenced, not just whether "society" was better or worse off.

Friedland and Barton, and Feller et al. looked beyond market interactions to consider more directly the rules of the game, as well as how the distribution of resources influenced who was able to benefit. These were more social models, including but not limited to market activity. Individual actors were more directly considered, believing that individual actions and the type of relationships between

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[11]Weighting the losses and benefits to different groups may lead to different interpretations, but does not change this concern for total benefits and losses.

groups have an influence on outcomes. Behavior was not limited to market negotiation, and benefits could be appropriated in different ways.

De Janvry, LeVeen and Runsten used a political economy model which explicitly noted how power influenced market rules, payoffs, and the appropriation of income. It was the broadest study, incorporating interactions between market actors, the government, and bureaucratic structures. The market was not seen as a relatively neutral structure, but instead reflected decisions made outside its constraints. "Society" did not exist, as other studies had assumed, because social conflict was the norm.

Disaggregating social structure was therefore vital because the distribution of benefits would accrue to those powerful groups able to capture it. Because more social divisions were recognized, the analysis looked at more potential beneficiaries than any other study. This was the only study to consider the benefits gained by farm machinery manufacturers, banks, seed companies, landowners, and industrial workers, even though part of the public controversy surrounding the mechanical tomato harvester was specifically about benefits accruing to some of these actors.[12]

The qualitative studies shared some of the concern over market prices and quantities, because these help determine

[12]See Hightower 1973; Martin and Olmstead 1985; Sun 1984.

the size of benefits and costs. But more concern was placed on the actual behaviors and incentives faced by groups, believing that these not only influence the size, but also the distribution of effects.

Relevant data included interviews with participants (key actors and authorities, such as extension agents, familiar with the subject), and previous writings from a variety of disciplines on the case. Much of this interest was specifically on the institutional structure and how it influenced the direction and type of change which occurred.

Social welfare information was taken directly from these observations, incorporating a range of concerns. This diversity made it impossible to quantify a single welfare result, as had been done in the Economic Surplus studies, but necessitated lists. The distributive impact on different groups was expressed separately, not as a single aggregation of effects.

The choices between methodology and underlying distributive model in all these studies were not arbitrary, but based on the experiences of the analyst. The one most approximating experience was usually chosen. Comparison of results between perfectly competitive and monopoly models can be done, but the appropriateness of the particular model depends upon the value judgments of the analyst, including the intent of the research, not on the scientific approach itself. Choices about qualitative approaches were similarly products of the analysts' value judgments.

c. Theoretical Differences

Even once the methodology has been chosen, with its concomitant suggestion of what is important to consider, some theoretical choices are still necessary to flesh out the analysis. This arises in large part because productivity change and income distribution is complex, forcing obvious decisions to implement the chosen methodology. The choices in general are threefold: the boundaries of study (what specific elements are considered relevant for inclusion, and their precise definition), how change is measured (numeraire and standard for comparison), and what happened (causation). These are not independent of methodology or the intention of the research, but are the specific choices required for a methodological approach to be applied.

i. Boundaries of Study

The judgment about the specific variables (including definitions) to be included in analysis is a concern for the boundaries of study. The chosen methodology will suggest general variables, but these still must be applied to the specific case, forcing analyst judgments about how to interpret events (for example, is a specific actor a "producer," a "consumer," or neither).

One aspect of the tomato harvester stressed by several of the authors (Rasmussen 1968; Feller et al.; de Janvry, LeVeen and Runsten; Friedland and Barton) was that its successful development and adoption clearly involved lots of innovations and adjustments in all aspects of tomato production. The tomato harvester required changes in the genetic characteristics of tomatoes, managerial skill in bed preparation, planting, thinning, irrigation, the organization and recruitment of labor, methods of handling output, sampling methods for grading, accommodation at processing plants, and timeliness of harvest, as well as the physical design of the machine itself. This technological change thus simultaneously involved biological changes, institutional changes, and changes in human capabilities. Each was essential for successful development and adoption, making separation of these influences nearly impossible.

Further complicating analysis was the way other incidental inputs changed simultaneously with the innovation of interest. During adoption of the tomato harvester, for example, the California Water System began operating, allowing very large farms in the San Joaquin Valley to take even greater advantage of the harvester. Few tomatoes were produced in the valley pre- harvester and pre-irrigation, so the geographical shift of tomato production could have occurred for either reason.

Determining the injuries and gains from change is problematic,[13] requiring an unenviable choice between simply accepting the judgments (definitions) of damage from the status quo rights, or attempting to describe these outside the formal recognition of the existing institutional structure. Neither are attractive options.

Taking the status quo demarcation as given is unappealing because it misses the mechanisms determining which injuries are deemed "damage" (and hence compensable) or "bad luck," and the inputs and outputs deemed factors and products, at the heart of distribution and change. Most Cost Benefit analyses go beyond these status quo judgments, recognizing that displacement costs and other outcomes of change are important even though they may not be recognized by the status quo under study. The alternative method of merely describing the injuries and gains without concern for their formal recognition by the existing institutional structure is also unappealing because it requires difficult normative judgments about which injuries and gains are important enough to include in analysis.

The boundary choice affects which of these influences (or others) are included in the analysis, including whether the influences are considered separately or at the same time. The methodology has obvious impact on what is chosen, but

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[13]Refering here to the definition, not the value. Discerning the value will be discussed in the next section.

different decisions easily and legitimately occur even within the same methodology.

ii. Measurement of Change

Determining the type and extent of change which occurred involves several interdependent decisions. The chosen methodology helps highlight options, as with boundaries, but the choices are separate from methodology. The appropriate numeraire of comparison must be decided upon, whether it is price based (such as income) or qualitative, and including its specific definition. Secondly, some standard for comparison is necessary. This choice frequently is the "what *would* have happened if the change had not occurred," a speculative enterprise because it did not occur. Both numeraire and standard are necessary to study change.

1. Appropriate Numeraire

The choice of numeraire determines what kind of comparisons can be made, how benefits and losses are measured (and thus their discerned values), and the type of conclusions possible. It provides a standard with which to see the direction of change, and can be used to estimate the degree of change that occurred. Numeraires can be universal, applying to all groups and thus allowing interpersonal comparisons, or be limited to intra-group comparisons. A study can rely solely upon one numeraire for its conclusions, or use several, weighting their different results as the analyst chooses.

The numeraires used in the tomato harvester studies fell into two general categories: price based, and qualitative. All the consumer surplus analyses except Price's relied almost exclusively upon economic surplus measures, derived from prices and quantities, for comparisons between groups. Changes in output and changes in price, combined with social welfare assumptions about the appropriate definition of benefits and losses, were used to produce dollar-based welfare estimates of how much different groups benefited and lost with the adoption of mechanical tomato harvesters. The authors differed in their methods of calculating consumer and producer surpluses, but believed that these imputed welfare measures were appropriate for comparing the benefits and losses occurring between groups. Price also used this technique but noticed that if the losses and benefits of different groups are weighted differently it does not take much change in relative weights to see the harvester as bad for society instead of good. Value decisions about weights are unavoidable (Bieri 1972), making the results dependent upon the judgments.

Price also tempered his economic surplus estimates by simultaneously considering more qualitative numeraires. These type of numeraires were also used by Friedland and Barton, de Janvry, LeVeen and Runsten, and Feller et al. Qualitative numeraires do not attempt to compare between groups, but instead describe what has changed with each group, using each group's definitions of importance. The qualitative results from these studies reflected the authors refusal to try to quantify all the benefits and losses involved, or to impose a social welfare function. This would have been inconsistent with the social focus of their analysis, because such functions assume social consensus on what is desirable. The studies instead tried to describe how relative opportunities had changed without attributing specific welfare implications to these.

Simply choosing income as the numeraire does not avoid this problem, because defining income is a surprisingly difficult task, despite its familiarity. A myriad of different definitions exist, reflecting individual perspectives as much as the diversity of questions it is used to help answer.

Decisions about the definition of income include specifying the unit of observation, what type of income is of interest, the components of income deemed relevant, and the definition of these components. Unit considerations include whether income should be defined as per person, per family, or per another unit of organization, and whether income of interest is that from a specific task or from all an actor participates in (total income). With farm level analysis this involves whether relevant income is farm income alone, or both farm and off-farm income.

Gross income can be of several types. These include income relative to prices (real income, in the parlance of most economists), relative to other actors' income, in nominal terms, and differentiating between money and noncash income. Converting nominal incomes to "real" incomes (with respect to prices) is a common procedure by economists, ostensibly to take into consideration the effect of price inflation on the real buying power of a given income. Less common but with similar intent is to convert incomes to "real" incomes with respect to other actors' incomes. This makes sense because actors view their own income with regard to the income of others they identify with (groups Thurow (1984) and other labor economists call "reference groups"), not in nominal terms.

Both conversions from nominal income involve some welfare concerns, but the former is usually not noticed. There is a difficulty "in terms of the distinction between welfare and income" when the price of a commodity falls and nominal income is unchanged through productivity change (H. Johnson 1973 p. 66), a situation almost identical to calculating income with respect to price changes. The reference group conversion is no less scientific than the former, even if it is conducted less frequently.

Income with respect to others' income is important in agriculture because of the declining terms of trade. The differences between the standards of living in agricultural and in nonagricultural sectors was one important factor stimulating migration out of agriculture during the past half century. This "social" context is thus very helpful in understanding the origins of change.

Another distinction is between cash and noncash income. Cash income is a very limited definition but it offers relatively easier data collection because it avoids imputing values. Including noncash income expands analysis to recognize the multifarious methods income accrues to actors,[14] but requires that the value of these be estimated. Choosing which noncash benefits are germane is similarly problematic, but involves no more of a value judgment (or arbitrariness) than simply avoiding noncash income altogether.

The components deemed relevant for income depend in part, of course, on whether the subject includes noncash income. The traditional components of income, wages, rents, and profits, are usually cash oriented, though they can be defined to embrace noncash benefits. Other components worthy of attention here include capital gains, transfers, access to

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[14]Noncash income can include, among others, payments in kind, home consumption, pension payments, health insurance or services, fringe benefits such as free business lunches or use of company cars, training, unrealized capital gains, and indirect subsidies.

in-kind goods and services including education and natural resources, the related problems of defining "displacement costs," and incidence of taxation.

Capital gains provide a bridge between income and wealth, recognizing that both are interrelated. When asset values appreciate (or depreciate) the change in value can be construed as a change in income. Realized capital gains are usually distinguished from unrealized, the former being gains which have been captured through sale of the asset while the latter consists "merely" of owning a more valuable asset.

In agriculture, capital gains and losses are especially important for landowning farmers. Cochrane argues that major benefits of government programs accrue to landowners via such capitalization (Cochrane 1985), while in recent years the capital losses associated with falling land values have severely affected different producers' credit positions and hindered their access to necessary short run operating loans. Productivity change causes similar effects by changing the relative value of different assets, including land and managerial skill. It could be argued that unrealized capital gains should be excluded from analysis because they are unrealized, but the influence they have on credit availability and other operations necessitates inclusion.

Other components, such as transfers, subsidies, or displacement costs, are problematic because their definition depends upon the definition of rights. They cannot be

determined without prior definition, but as effective rules and rights change the definitions as well as the individual values can be altered. This raises an identification problem, because the analysis cannot avoid implicitly relying upon the very things it is trying to explain.

Numeraires for productivity are especially problematic, because productivity changes as the definition of factors and product are altered. It is also vital to consider who productivity is defined in terms of: product per worker, product per unit of factor X, and ratio of value of product to value of factors (either in terms of value to the entrepreneur or to the public) are possible.

The Marginal Productivity Theory technique of using income as a proxy for productivity not only confuses the two (Samuels 1982b), but also fails to solve relativity problems: it attempts to avoid the difficulty of physically comparing factors and product across time (while the definition of factors and product changes simultaneously) by appropriating the difficulty of comparing values, even though values (prices) are as integral a product of institutional context as the definitions of physical goods.

2. What Would Have Happened

The final crucial element of measuring change involves the baseline for comparison. This can be the "reference transaction" discussed by Kahneman et al. (1986), a relevant precedent offering a "reference price or wage, and... a positive reference profit" (p. 729) providing a reference for assessing outcomes. Similarly, "what would have happened" (without the change under study) can be the standard used to see the relative effects of change.

As de Janvry, LeVeen and Runsten said, "In assessing the impact of the machine, it is extremely important how one specifies the alternative production possibilities" (p. 157). Simply comparing "before" and "after" presupposes that if the change had not occurred nothing else would have changed either. Alternative (and more realistic but difficult) comparisons would realize that something else would have happened if the change under study had not occurred, and use this "alternative" as the basis of comparison.

The tomato harvester studies offered various conceptions. Schmitz and Seckler's use of cost savings times quantity assumed that the industry would not have changed at all without the harvester. Brandt and French explicitly investigated four possibilities, depending upon different wage rates that could have occurred. These were simulated with econometric estimates of market relationships. De Janvry, LeVeen and Runsten claimed that production could have been reorganized as was done in several other commodities at the end of the Bracero Program, or that canning tomato production could have moved to Mexico. Other authors mentioned this latter possibility, arising because higher wages could have made domestic production uneconomical, but de Janvry, LeVeen and Runsten was the only study to note that retail prices would likely have been lower under this shift than occurred with the mechanization. This means consumers are now paying more because of the harvester than they would have without it's adoption, contrary to most other studies' conclusions. Thus conclusions about the effects of the tomato harvester depend, not only on observing and interpreting what happened, but equally on projecting what would have occurred.

Choice of reference is vital, because it influences the conclusions by providing the major point of comparison. Agreement on general principles "does not preclude disputes about specific cases" because the relevant reference is not always unique (Kahneman et al. p. 730). Unfortunately for analysis, the "what would have happened" is a speculative enterprise, not directly observable. Inferences must be made, with the results dependent upon the interpretation of the analyst, not merely the data itself.

iii. Why It Happened

Once the relevant elements and the events which occurred have been identified, discerning the cause of the events is necessary. This is equally a product of the analyst's judgments, both individually through the choice of methodology, boundaries, numeraire, and "what would have happened," and through interpretation of events from this chosen perspective. Successful adoption of the Mechanical Tomato Harvester, for example, equally involved biological, institutional, and human capability changes, as well as the obvious mechanical change:[15] to what is the productivity increase of adoption properly due? The framing of the analysis (boundaries and events) are vital for influencing what causal connections are found.

In Griliches (1958) estimate of the social rate of return to hybrid corn research, he used plant breeders' estimates of hybrid superiority to calculate the "loss in total corn production that would have resulted if there were no hybrid corn" (p. 421). The value of additional resources used with hybrid production were estimated by multiplying the difference between the price of hybrid and nonhybrid seed by the quantity of seed used. This essentially ignored other resources equally necessary for exploiting the capabilities of hybrids: increased use of fertilizers, different cultural practices, extension efforts, and other things which would influence yields. Based on breeders' quotes, Griliches assumed that the

[15]New plants (with simultaneously ripening fruits easily separated from the vine, relatively impervious to bruising or splitting), new handling systems (new grower equipment, processor handling, sampling methods for grading, and sorting), increased care and precision in cultivation and timing of harvest, and increased importance of weather (it must be dry to mechanically harvest) were all necessary for its productivity. Further muddling the contributions of the harvester towards observed results, was the simultaneous start up of the California Water System which allowed very large farms in the San Joaquin Valley to begin growing tomatoes.

only additional expense of hybrids was the difference in the value of the seed.

It is not clear if the breeders' estimates were increases given the same cultural practices, fertilizer use, and other inputs commonly used with open pollinated corn, or were increases only possible with these changes. If the former, the actual yield declines would have been even greater than Griliches' 15 percent if farmers completely returned to the inputs previously used with open pollinated corn. If the latter, the social rate of return from hybrids is seriously overestimated, in that all the observed production increases are attributed to the new variety without regard for how other inputs changed.

Clearly, the tremendous yield increases occurring during adoption of hybrids were equally a product of other influences. Yield increases of corn were "16 percent in the corn belt between 1920 and 1945. Meantime, (nonhybrid) wheat yields in the U.S. had increased 36 percent!" (Berlan p. 27) Corn yields in the south were extremely low "until the mid or late fifties when... hybrid yields rose dramatically. The change was associated with the introduction of newer hybrids, a greater (and more effective) use of fertilizers, and altered planting densities" (Dixon 1980 p. 1459).

> If we add that the use of commercial fertilizer in corn belt corn increased several times between the mid 30's and the mid 40's, that machinery had made fantastic strides in 25 years, that soybean acreage was increasing rapidly, providing a balanced rotation and that these factors contributed more to corn yield increases than to wheat yield increases, it casts some doubt over the intrinsic superiority of the new method of breeding.
>
> (Berlan p. 27)

If the yield increases used in Griliches study were those occurring with the package of new factors as well as hybrids, the omission of the other factors inflates the contributions and causal importance of hybrids.

4. Observability

One of the difficulties inherent in studying this topic are the observability problems. These force analytical judgments and compromises, influencing the theoretical choices. Two kinds will be discussed, followed by the role they played in the tomato harvester studies.

a. Static Observability

The sensitivity of income data increases the difficulty of its collection. Actors have more reasons to hide, disguise or misrepresent data, and are more concerned with its dissemination. Access to information is thus harder because self reporting is less reliable and income is more proprietary than most other relevant data. Added to the already intractable problems of estimating the value of certain noncash income components (such as indirect transfers and unrealized capital gains), and differentiating between the wage, rent, and profit contributions to a professional's income (farmers and other self-employed actors, for example), this renders empirical analysis of income even more unreliable and judgmental.

The difficulty of observing income further varies across income groups. The source of income is important, as is the transience of the group. Some groups, such as skilled laborer, whose income is primarily composed of wages, are relatively easy. Others whose income comes from many disparate sources, especially capital gains or profits, are more difficult. Unfortunately, some of the most important groups involved in productivity change in agriculture belong to this latter group.

The distribution to migrant workers can be problematic because their transience makes estimating their yearly earnings difficult, as it does when calculating the costs of displacement. Estimating reemployment possibilities, search costs, or however displacement costs are defined is made more difficult because migrants are harder to follow than those actors with a permanent location. Social norms may be different for this group as well, requiring a different unit of analysis (family) than with other actors.

Calculating farm income is ripe with difficulty because many of the sources of income are not directly observable. Capital gains (losses) in land have been highly important in recent years. Depreciation (appreciation) of the large capital stock of farms is hard to observe directly, but is important because of the large investment involved. Unrealized capital gains can be as important for farmers as realized gains because they can play a crucial role in access to short run operating loans. Imputing the value of home consumption (admittedly less important now than previously), and use of farm buildings and vehicles is similarly important but difficult. These problems are over and above those of calculating "normal" off-farm incomes, because much farm family income is derived from non-farm jobs. The only relatively easy observation involves the level of direct government transfers.

Indices for converting nominal to real incomes (with respect to other prices) are commonly estimated and accepted by economists. But developing similar indices with respect to reference groups, as actors themselves perceive their income, would be more problematic. The reference group for each actor is specific to that actor, depending upon geographic location, social class, occupation, age, race, and other aspects of identification. Individual indices would have to be estimated for each actor taking these factors into account, compounding the empirical difficulties of analysis.

A related observational difficulty is seeing the "productive contribution" actors make towards production (especially important when using Marginal Productivity). Besides requiring inference of the "productive inputs," it also necessitates separating the distribution of income from these value productivity contributions to avoid the circularity of what Samuels calls taking income as a surrogate for, and indication of, productivity (1982b p.7). Without this separation of productivity and income "contribution-based" income theories cannot avoid circularity and untestability.[16]

b. Observability of Change

Adding a temporal dimension to income simultaneously adds more observational problems, but allows additional possible considerations about income. These include the stability of income, and comparing income across time to see the effects of change.

Stability of income is important for agriculture, because of the well known production cycles and fluctuations arising

[16]Because both productivity and income are dependent upon the structure of rights such a division may well be impossible. Both require a simultaneous public choice decision about what contributes to production and thus which claims are entitled to income arising from that production.

from weather, seasonality, and other acts of god. The size and period of variability is as important as the mean across time, because the short run fluctuations can be deep or long enough that producers are not able to survive for the long run. Economic behaviors by actors in many cases are attempts to minimize instability as much as to maximize income.

Observing income change across time involves several related problems. Besides compounding the static observation difficulties, numeraires for income, inputs and output become necessary to show that change has occurred and the magnitude of that change. To be able to say anything about the change two further considerations are required, both steeped in the theoretical orientation, but requiring empirical roots. Discerning the cause of change is important, as is determining what the relevant comparisons are between (the "what would have happened" question).

Index problems arise with both inputs and outputs, especially if productivity change is seen to arise from input quality changes. Measurement of these factors in a manner separate from their value is hard but necessary to avoid circularity. The indexing method used is critical because any "residuals" discovered could arise from the method as easily as from actual productivity change. This raises more possibilities for obfuscation between studies.

Similar problems arise with productivity change, because most productivity indices must grapple first with inputs and output. Indices are constructed, but the literature is in conflict about the correct method of doing so. They are not accurate enough to produce an elasticity of productivity change,[17] even if such an elasticity made conceptual sense (which it does not). By its nature productivity is a function of the institutional framework which weights preferences, sanctions "relevant" inputs and output, and determines claims to ownership. An index across institutional frameworks, as would be required in this study, would be difficult to construct.

Income comparisons between groups are often relegated to Welfare Economics in an effort to find an appropriate numeraire. Even though this study is not trying to compare income between groups, intertemporal comparisons within the same groups raise some of the same welfare questions.

c. In the Harvester Studies

Economic surpluses are not observable, but have to be derived from observed quantities and prices, creating different results due to procedural differences. Schmitz and Seckler, Price, and Brandt and French relied upon observed prices, but utilized different methods for calculating surpluses. Kim et al. used a two step process, first imputing

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[17]Showing that a 1 percent productivity change gives a ___ percent change in the income of actor____.

"competitive" prices from observed prices, and then calculating economic surpluses from these.

With the tomato harvester studies, calculating costs proved contentious, especially those related to labor displacement. Tracing the costs of unemployment was difficult, so most of the authors tried to avoid this problem by merely acknowledging the displacement effects before discussing them in the abstract. Schmitz and Seckler looked at the range of possible reemployment (0 to 100 percent), but limited the costs of displacement to foregone wages. Price considered the same range, but by looking at workers' job qualifications decided reemployment was not likely. He used a wider definition of displacement costs, deciding relevant displacement costs included such things as the effect on workers' children.

Observability problems also influenced the more qualitative analyses. These analyses discussed effects of the adoption of tomato harvesters, but were not always able to adequately quantify those changes because the data was not clearly observable. There is little doubt that some processors would have suffered fixed asset losses if the industry had moved to Mexico, but actual information on what those losses would have been are not obtainable. Similar estimates for losses to small Californian producers who were driven into other commodities, or for asset losses to tomato producers in other states because of the mechanical harvester are also so hard to obtain that any estimates must be treated with caution. The authors could discuss these kind of losses, but observability problems made it impossible to compare these effects quantitatively.

B. Where This Leaves Analysis

It should be apparent from the literature review and discussion of the tomato harvester studies that evaluating the distributive effects of productivity change is a difficult, value laden process. Normative judgments are necessary throughout the course of analysis, having great bearing on the types and levels of results discerned. The interpretation of an event depends upon whose rights were perceived as being involved, implicitly chosen during boundary and numeraire decisions. Different tales about the same event can legitimately be told, depending upon which rights are held as sovereign and what variables are seen as worth including. This includes the distribution of injuries and gains, the nature of actors' behaviors, and the basis of government programs.[18] The preconceptions of the analyst flavor what is discerned.

The Neoclassical studies of the tomato harvester were simply estimates of how much welfare had increased or

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[18]Farm income programs can be equally perceived as a subsidy or as compensation, for example, depending upon perspective.

decreased, without major investigation into <u>why</u> it had changed. The distributive concerns arose during the analysis, both during choice of distributive model (competitive or monopoly) and at the time weights were applied to each group's benefits and losses. Institutional influences were considered primarily to help choose which model seemed appropriate or whether compensation actually occurred, not directly during the analysis. Interpretative value judgments (about the goodness or badness of the change) were primarily hidden during the process of creating the consumer surplus estimates (by group weights), not during the conclusions.

Results from the qualitative studies were more complex because they were multidimensional. Instead of describing the effects of change through use of a universal social welfare function, they relied more upon describing how social relationships, the numbers of actors, wages, and other factors had changed. The types of change specified were dependent upon the relationships seen as important by the model. Results could not be meaningfully expressed in a single number, but had to be outlined in a more complex manner. This could be misinterpreted as showing that nothing had been proved or answered, or that analysis was sloppy and unscientific.

The normative value of these results was typically not judged because the analysts generally refused to impose social welfare measures on events. Instead of being told that consumers benefited by some quantity, as in many of Neoclassical studies, the results simply stated that consumers paid less (or more) than they would have without the mechanical harvester. It was generally left up to the reader to provide the value interpretation of the events described. This allowed the studies to be more useful to those who disagree with the interpretative judgments of the analyst, because the studies had not been built entirely around a social welfare judgement as is done with Economic Surplus.

All the studies, however, were the product of judgments about methodology and theoretical choices, even if results were not ascribed normative merit. The studied events are observed by the analyst through a paradigm of relationship which help structure experience and provides interpretation of those events. It is not possible to let events "speak for themselves" because humans only "hear" (perceive) through expectations and experience which provide meaning to the observations. The choices about how to perceive the events (methodological and theoretical) controls what will be discovered.

The paradox of analysis is that the researcher effectively must choose what happened (through choice of methodology, boundaries, numeraire and causality) to be able to learn what happened. The paradigmmatic choices which influence what is perceived must be made before the event is observed, meaning that understanding of events (the point of research) depends upon how it is interpreted, not just on the event itself.

The choices about methodology and theory cannot be based on scientific judgments because they give meaning to science, and thus occur prior to it. The comparison of alternative choices is done through nonscientific judgments, the reason McCloskey focuses on rhetoric's vital role in economics. The appropriateness of an approach depends upon value judgments of the analyst, as do the "significance" or reasonableness of results.

Events are experienced by actors differently, depending upon their interests. Economic analysis cannot be neutral in this environment, because by choosing what story to tell about an event (through methodological and theoretical choices) it unavoidably legitimizes the interests of the actor(s) whose story it resembles while deprecating the interests of those whose experience of the event was different.

Some facts about an event may be undisputable: mechanical tomato harvesters were used on farms in California, the number of hours of labor needed for harvest fell, the growers' per acre harvest cost declined. The interpretation of these, including the causal connections such as imputing why mechanical harvesters were used (to save growers threatened by labor shortages? Or to replace workers with machines?), and the benefits and costs involved (were growers damaged by the end of the Bracero Program? Is the monotony of mechanical work less desirable than hand harvest? Were workers "displaced," and if so, at what cost to them?) are viewed differently by the various actors involved. The analyst's interpretation lends legitimacy to whomever's perspective is mirrored. This is important with social science, because the results of the research can influence the legitimacy of actor's claims.

This subjectivity does not mean that economic knowledge is meaningless or necessarily is a tool of manipulation. The knowledge is tested against experience, allowing hypotheses to be tested and rejected. It simply requires recognizing that economics reflects some perspective of experience, and that other experiences may be as truthful. Validity depends upon personal judgment (whether explicitly or through some arbitrary decision rule), not on objective truth. The researcher must choose what they find appropriate, while at the same time realizing that their efforts will never be universally valid.

It is with that understanding that I assert that I do not find Neoclassical approaches appropriate for analyzing productivity change. It is clear that many nonmarket actions influence the types of change occurring and their distributive effects, but the Neoclassical interest only focuses within this context of choices about markets, after these vital decisions have been made. The Economic Surplus approach encompasses too many hidden value assumptions in the interpretation of results, and is informative only if the measure is accepted as a valid representation of welfare. Marginal Productivity Theory is similarly undesirable here because of its limitations and narrow focus. As Blaug said, "in the presence of technological change, the Marginal Productivity Theory of distribution hardly warrants the title of theory, consisting for the most part of boxes into which evidence can be put with little assurance that another box would not do equally well" (1986 p. 484).

A qualitative approach seems more appropriate because it allows consideration of the rules as well as behaviors, and permits inclusion of more actors. Common's concern with changing rights and human relationships would be a central focus, because it allows a more complete perspective on the range of choices involved in productivity change and income distribution. This is not a coherent theoretical package, however, which can simply be taken and applied. It also lacks some of Marginal Productivity Theory's conciseness about factor substitutability and other technical relationships, which are important elements for change and distribution.

Chapter 4

Entitlement and Productivity Framework

A. Choice

The choices within a market are more than the mere consumption and production decisions represented as supply and demand. Supply and demand are preceded by other decisions which define who can express their preferences, the rules of expression, the methods of weighting those preferences, the goods, and other important aspects which give substance to markets. Supply and demand are meaningless without prior choices about the market in which they occur.

A useful conceptualization of the market, which includes the range of necessary choices, comes from J.R. Commons. He suggested that in every transaction there is conflict of interest, dependence, and order. This helps conceptualize the necessary role of institutions, and explains the diversity of observed behavior.

Conflicts arise because interests differ and actors are unavoidably interdependent. Individuals have choice "only with respect to the opportunity set open to (them) as a consequence of (their) interaction with others" (Samuels 1981 p. 12), because interdependence is unavoidable and ubiquitous.[1] The choices of each person affect the range of choices available to others.

Rules[2] are necessary to provide order to the world, delineating how conflicts will be resolved and which interests will predominate under interdependence. The effectiveness of rules (which interests are favored) and de facto entitlements to income depend equally upon the type of interdependence (and conflict to be resolved) and the rules themselves. The interaction of rules and interdependence comprise the institutional structure (or order) of that market, effectively serving to define the actors, means of exchange, and endowments, as well as efficiency, goods, and productivity.

Rules can never be neutral in an interdependent world, because they always unavoidably favor some interests over others: a right for one person means an obligation for another. Property rights and rules "order the opportunities for one person to affect another and vice versa by influencing what both parties take into account in their decisions" (Schmid 1987 p. 41). They affect <u>whose</u> costs and benefits enter the calculations that determine resource allocation (Carter 1985 p. 799).

[1]An extensive literature relies upon or explores interdependence of market participants to explain performance: Carter 1985; Furubotn & Pejovich 1972; Randall 1972, 1974; Samuels 1978, 1981, 1982, 1987; Samuels & Mercuro 1979, 1980; Schmid 1987; Shaffer mimeo, 1969.

[2]Whether explicitly demarcated or by default.

This occurs whether the institutional structure arises by default or conscious choice, because "where there is interdependence, there is an effective right to control it" (Schmid 1987 p. 139). Nonneutrality applies to government (Seidman; Samuels 1982) by proxy of its effective power to structure markets, regulation (Samuels 1978), output (Samuels 1978), and productivity. Supply and demand, receiving specification from these, reflect the interests favored within the institutional structure. The meaning of efficiency is equally unique to the market's institutional structure, changing as rules or other aspects of the structure change (Lang; Schmid 1987; Shaffer 1985). The institutional structure cannot be chosen on the basis of efficiency or relative prices because the decision gives definition to these and thus must occur prior to it. Power is an important influence on market outcomes through its influence on the institutional structure and the definition of efficiency, even when power is not expressed directly in consumption and production decisions.

Williamson (1985) argues against the importance of power in his response to Marglin's (1974 pp. 104-108) study of technological change, in which Marglin argued power was important for the change from handmills to watermills during feudal times. Williamson misses the crucial point that "efficiency" depends upon whose perspectives and preferences are favored in market rules, a result of power. With handmill-watermills, the Lords' rights to a share of peasants' grain conflicted with peasants' rights to mill grain at home and to self report production. The feudal Lords used their power to outlaw the use of handmills, redefining the market goals and rules which give efficiency meaning, and forcing peasants to use the Lords' watermills. In cases when the balance of power shifted towards peasants, "one of the first casualties was the Lord's monopoly on grain-milling" (Marglin 1974 p. 107), changing the rules and thus effective definition of efficiency.[3]

Scarcity arises from within the adjudication of interdependence, as does productivity, dependent upon whose interests are counted. This does not say that supply and demand (or Marginal Productivity Theory) are unimportant, only that these work within and are unique to the context of choices. Decisions about whose interests will count (as embodied in the structure of rights) create effective supply and demand, and thus the prices, quantities, and income unique to that framework. A different structure of rights yields

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[3]The insights from Transactions Cost Economics, like Williamson, are useful, but with the understanding that "efficiency" occurs <u>after</u> their analysis, not as an explanation! Actors try to minimize their own costs, and so attempt to mold order in this manner. But minimization for one person is not minimization for another (under interdependence), causing conflict over what should <u>be</u> "efficiency."

Induced Institutional Innovation theories suffer from the same misunderstanding, because they assume "efficiency" as reflected by the market necessarily mirrors everyones' interests rather than just a few.

different effective supply and demand, and thus different prices, quantities, and income.

Four types of choices can be discerned as especially important for market outcomes. Choices of order (the institutional structure) resolve conflicts from interdependence and determine whose claims on income are recognized. Focus on the conflicts of interdependence helps identify which institutions are particularly important. Choices between methods of production for a given good, within the context of order (and thus definition and control of resources), determine what factors are necessary and who must deal with whom for production to occur. The alternatives are those known within the state of knowledge.[4] New alternatives, arising from a change of knowledge, can change the relative need for certain inputs and economic power. Choices about the state of knowledge, expressed as research, development or learning, influence the types of new knowledge discovered and thus the changes wrought by technical progress.

The fourth choice of interest are consumption and production decisions (including which goods) within this context of prior choices. Effort (or quality) decisions occur

[4]"Knowledge" and "information" are not identical. Knowledge is defined here as data on how to relate inputs and outputs. The "state of knowledge" refers to that knowledge currently available, (i.e. the technological alternatives), a function of social organization instead of any inherent "correctness" of the knowledge itself. "Information" is data about the actions of others, preferences, prices, rules, etc. It is data about the state of the world.

at this stage as well.[5] This is the relatively familiar realm of supply and demand, but clearly the product of decisions about the institutional structure.

This chapter will present these choices and the elements involved in their resolution. The implications from this perspective about productivity and the distributive impact of technical change (level and direction of change, and division of benefits) will then be discussed. Finally, specific variables to consider in analysis will be outlined.

One caveat is important: this focus is actor-centered rather than good-centered, explicitly assuming that goods have no meaning without definition from actors.[6] This means analysis must be specific to particular cases, instead of being general, because variables have meaning only within a specific context. The paradigm presented here consists of elements to observe rather than of a tight general model. It is meant to be applied.

It is also worth reiterating my desire to investigate productivity change and income in a descriptive and not prescriptive manner. I want to explore the nature of _present_ claims on production as expressed in agriculture, without

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[5]Recognizing that the quality of inputs, like labor, can vary depending upon the incentives (Thurow 1984, Stiglitz 1987).

[6]The physical world is not things, but uses and costs (Parsons). Resources _become_, through human definition, instead of existing in and of themselves (DeGregori 1986).

judgment of rightness or wrongness. This is not meant to defend or attack present entitlements, nor to suggest a "better" way of allocating the benefits of productivity change, but merely to positively describe the nature of existing claims. Evaluations of "justice" are thus outside of current interest.

1. Choices of Order

With interdependence, some order is necessary to resolve conflict. These can be consciously chosen rules or by default, with their effectiveness dependent upon the types of underlying conflict (and interdependence). A rule specifying ownership of a good, for example, means little if the owner is unable to exclude others from using the good. The order influences how the choices of actors affect others effective abilities to claim income.

Entitlements derive from how the rules arbitrate conflicts, not from the formal rules themselves. The rules include the types of organizations allowed to exist (cooperatives, partnerships, corporations, etc), rules of exchange (pricing mechanisms, contracting, and order of choosing), definition of goods, and formal claims on production. The effectiveness of these rules depends upon the type of underlying interdependence, which determine the conflicts needing arbitration. The combination of rules and interdependence, the institutional framework or order, influence the opportunity sets of actors by demarcating control and effective access to resources.

They also help interpret events by specifying whose interests are sovereign. Change inevitably effects injury on many different parties, but which of these injuries are "damage" (including costs) and which "bad luck" is not obvious without prior specifications of rights. These help us interpret an event by defining who has been hurt, who is responsible, and so forth. The specification of entitlements must occur before an event can be properly understood (compensation and judicial actions specify these when it is not clear which and whose rights are involved).

The mechanical tomato harvester provides a useful example of how the determination of rights affects which injuries are deemed damage and which bad luck. If growers are seen as having the right of access to labor, changes in the labor supply (such as the termination of the Bracero program, and the growth of union organizing) can be construed as damages inflicted upon growers which require compensation. The government (which ended the program), or workers who joined the union (and thus altered the labor market in a manner undesirable to growers) could be liable to pay for creating mechanical harvesters which would allow growers to adjust to the new labor conditions.

If workers instead are seen as having the right to employment in agricultural harvests (job property rights), they could demand compensation from growers for the labor-replacing adoption of these mechanical harvesters. Other possibilities of "damage" exist, depending upon the distribution of rights, including damages inflicted upon small growers who were unable to adopt the scale-demanding harvesters, damages on both labor and growers inflicted by the government which funded the research, damages on workers caused by the university research stations which developed the mechanical harvesters, or no damage at all from the change.

The order effectively interprets which of these perspectives will be supported through recognition and assignment of costs. This determines which inevitable injuries on others (because of interdependence) caused by an action must be remunerated, either prior to or after infliction. The assignment of injuries from the reduced need for hand harvest labor because of mechanical tomato harvesters, for example, has important implications for the distribution of benefits of change, as well as the direction of change through influence on the relative attractiveness of options considered by the potential adopter. Is the injury borne by growers (forced to pay compensation to displaced workers), displaced workers (if they receive no compensation), or by someone else (by taxpayers, for example, if displaced workers receive social welfare benefits), or some combination of these? The concept of "cost" unavoidably bears recognition of some claim, such as from displaced workers, while implicitly denying the interests of others. Benefits are similar.

The effective costs and benefits as defined by order arise from the combination of the type of interdependence involved in a situation, the status quo entitlements (recognized claims), and adjudications of compensation. Each of these influences will be investigated.

a. Sources of Interdependence

The effectiveness of "ownership" on claims to income depends upon the inherent nature of the goods involved. Schmid (1987) provides a useful taxonomy of these natures and the interdependencies they invoke, offering a way to predict which rules and rights are especially important in explaining performance, and a language to discuss these. The "situational" interdependencies he identifies as important include incompatible-use goods, high exclusion cost goods, economies of scale, joint-impact goods, transactions costs, surpluses, and fluctuating supply and demand.[7]

i. Incompatible-Use Goods (IUG)

An incompatible-use good is a good for which one person's use denies its use by others. This is the typical good in traditional economics (which often compares IUG's to "public

[7]For a much more detailed explanation than the following cursory summary, see Schmid (1987).

goods" which can be jointly consumed). If person A uses 100 pounds of hybrid seed, person B cannot use those same 100 pounds. A's use limits the opportunities of B by denying B the option of using those same pounds of seed.

Ownership of incompatible-use goods is the major rule arbitrating this interdependence, influencing "who can create costs for whom, with consequent effect on income distribution. Ownership influences whose interests are realized and whose are foregone" (p. 44). Ownership of an IUG allows a person to "deny its use to another or... to extract a payment in exchange for... consent" of use (p. 43-44).

ii. High Exclusion Cost Goods (HEC)

Ownership of a good, however, is ineffective if nonowners cannot be excluded from its use. Unauthorized users could consume without first obtaining permission from owners, limiting an owner's ability to extract payment from others for use. Some goods have inherently greater exclusion costs than others. The traditional categorization of "public goods" are high exclusion cost goods, with unauthorized users called free riders.

High exclusion costs can arise either from problems in detecting demand (whether the noncontributing agent really values the good inadvertently available to her through provision to others) or problems in detecting use of the good (p. 47). Factor ownership is less important for the distributive consequences than rights in such things as "government taxation and spending, marketing orders to restrict supply, union shops, etc" (p. 60) which provide some collective payment for use.

iii. Economies of Scale

Another type of interdependence arises when the unit costs of a product decrease as output quantity increases. Unlike constant cost industries, in which unit price is unchanged by the quantity demanded and where costs to consumer A are independent of the number of B's who share similar preferences, economies of scale involve interdependence of preferences. The more people who share the same taste, the lower will be the per unit price.

"One person's real income is influenced by the effective preferences of others, which affect where the producer is on the cost curve and thus the product curve. A's income is affected by rights that influence both the tastes and income of others" (p. 63).

This also arises for the cost of inputs. If the production of input X is subject to economies of scale, and input X is an important element for production of good A under one method of production but not under another alternative method, the cost of input X will be a function of the quantity of A produced under the X-using method, as will be the unit production cost of A produced with that method. This holds even if production of A itself is not subject to economies of scale. The comparative advantage of the X-dependent method or non-dependent method of producing A thus depends, in part, upon the quantity of A produced using economies of scale influenced X.

The distributively important rules concerning economies of scale involve the right of individuals (firms) not to use the product (input), barriers to trade, and pricing rules. The pricing rules are important, because they determine whether the marginal user pays the value of marginal product or marginal value of production, with concomitant effects on intramarginal users.

iv. Joint-Impact Goods (JIG)

Interdependence also arises when a good can be enjoyed by two or more actors without reducing the quantity of the good available to others. A major example is market information, where providing one more person with the information does not decrease the quantity or quality of the information available to everyone else.[8] The crucial characteristic of these joint-impact goods is that the marginal cost to add another user equals zero across some range.

[8]Provision of the information to others may affect the value of that information, but it does not affect the accuracy of that information.

Several issues arise with JIG's; the degree to which the availability to person A limits the choice of quality or quantity to B (p. 78), and the cost of avoiding the good or of excluding others. If a JIG cannot be varied for one user without simultaneously altering it to all others, it is called a preemptive JIG. National defense is a good example. The quality and quantity choice about a preemptive JIG preempts others abilities to choose, so who decides is crucial.

Similarly, the right to exclude others from a JIG is important for income distribution (p. 81). Knowledge is a JIG, but the right to patent or copyright ideas has clear distributive effects. The marginal cost of providing this knowledge to additional users is negligible, but owners are able to extract large payments for use.[9]

Rights in pricing policy are also important, because the right to charge for a marginal use with no cost of production "can be allocated without necessarily affecting the firm's break even point or the good's physical supply" (p. 83). The possibilities include giving the right to consumers "free of charge (as with the right to video record television programs for home use), to the owner who controls the decision on the fixed costs" (p. 83) (as with a patent holder's right to charge for use of the knowledge), or to any member of the public.

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[9]Their effectiveness in excluding others depends, of course, on the exclusion costs inherent in the knowledge.

The important distributive rules about JIG's thus involve the right to exclude, the preemptiveness of the JIG (with related importance of who chose), and the rights to price marginal uses.

v. Transactions Costs

Transactions costs also influence the distribution of income, because "the location of initial rights (under transactions costs) affects the eventual use of the resource even where market exchange is allowed" (p. 96). If the relevant transactions costs are too high, the initial possessor of the good will retain it even under market exchange purely because of the costs of transacting. Transactions costs can thus protect some interests by discouraging bids on a resource or entitlement while simultaneously working against other interests who desire to bid.

Schmid identifies three kinds of transactions costs; contractual costs (costs of reaching agreement with another party), policing costs (exclusion and other costs of enforcing agreements and rules), and information costs (costs of acquiring information about the product and factor price and quality now and in the future) (p. 95).[10] Contractual costs are especially influential if the number of people necessary

[10]Schmid's categorization is useful, though the specific definition of information costs used here differs slightly from his.

for negotiation is large (either because myriad people must individually agree to sell the right in question, forcing a buyer to negotiate separately with each, or if myriad people must agree to purchase the right in question. For example, the distribution of income from a new method of swine production which also increases odors would likely depend upon who had the initial right to the air. If the adopting farmer had the right to put odors into the air and neighbors had to buy that right to prevent their smelling his operation, the distribution (and likely the farmer's adoption decision) would be different than if the farmer had to buy the right from neighbors, because in either case the costs of contracting would probably prevent the potential purchasers from even bidding. The specific costs involved in contracting depend, of course, on who has the right in question and the bargaining rules in the economy.

Policing costs include the costs of excluding unauthorized users from a resource, as discussed with high exclusion cost goods and joint impact goods. They also include the cost of insuring that exchanges take place as both parties agree upon. Enforced federal grades and standards, for example, reduce the transactions costs of exchange borne by the individuals in a transaction by transferring some of the policing cost to the government. The grades mean that transactors need not inspect each package to see if the quality is as was claimed, and provides some legal recourse if a good was misrepresented.[11]

The costs of acquiring information about product and factor price and quality now and in the future are important because they influence the level of uncertainty and risk in economic decisions. High information costs increase the uncertainty in which actors operate. The information costs faced by actors differs between individuals, as does the decision about how much to allocate to information acquisition, resulting in some actors operating in less uncertainty than others.

Information costs also include those of acquiring information about the alternative methods available to produce a given good. This is simply information about which alternatives exist and their potential costs and benefits, not the specific knowledge needed to use those alternative production methods. High information costs can prevent some actors from choosing a prospectively beneficial method simply because the actors are not aware that the method is available.

Actors' perceptions of the relative attractiveness of options, including expectations of future prices, the level of uncertainty and risk, depends upon the information they have, a function of information costs. Information costs thus

[11]This occurs after exchange has occurred. Grades and standards also change the allocation of information costs by helping bidders know more about the goods for which they bid.

affect which options will be chosen. This is especially important for investment decisions involving immobile assets because inaccurate expectations can lead to loss of such investment.[12]

vi. Surpluses, and Demand and Supply Fluctuations

When people differ in their willingness to pay, or resources differ in their productivity, surpluses are created whose division depends upon rights (p. 132). The type of pricing mechanism is the central question when willingness to pay differs: price differentiation in practice has the same effect as a tax (p. 133). When resources vary in productivity, ownership of generated surpluses is at issue. These include who owns the increased value of land or other assets due to public action, and rents from change.

Pricing policy is also important when supply or demand fluctuate. "The implicit right involved in peak-load pricing schemes is a factor in income distribution" (p. 137). Questions involve determining the marginal user if peak load users are to pay more, or whether everyone should be charged a flat rate.

[12]The cost of "guessing wrong" and losing an immobile investment may arise because of information inaccuracies, but the capital loss is not defined here as an "information cost." Information costs refer to the costs of learning about the state of the world, and nothing more. Immobile assets and risk will be discussed further under choices of method.

b. Entitlements

Entitlements are the claims on income in an economy. Entitlements here refer to the effective basis of the actual claims on streams of income effectuated in the economy, without regard for origin or ethical correctness. They do not refer to the level of the streams of income[13] nor to formal claims (such as ownership) which are unenforceable, but to the effective claims resulting from the interaction of formal rules, interdependence and enforcement. Entitlements are part of the order that determines which interests will predominate under interdependence.

The value of entitlements refers to the value of the claims on the stream of income, determined most frequently from the interaction of supply and demand within the market context. This distinction between entitlements and their value does not hold for all cases. The value of some entitlements, such as the income which arises in the form of grants outside of the market, is determined at the same time the entitlements themselves are created. Deficiency payments, for example, are jointly decided (entitlement and value) through political power. The distinction between entitlement and value of entitlement is useful, however, to avoid

[13]i.e. increased demand for Oldsmobiles does not change General Motor's entitlements, though it may increase the value of those claims.

confusion when discussing income directly affected by supply and demand.

Knowing the types of interdependence involved in the particular case under study, as well as the institutional response to those interdependencies, is vital. These include the relevant situational interdependencies and the market rules and procedures, structure of organizations, norms, and endowments which resolve them. Entitlements arise from within this complex milieu, placing them within a constant state of flux and rendering generalizations difficult except for specific cases, times and contexts.

The institutional responses are choices of order (whether conscious or by default), subject to political, economic and administrative power. Political power helps assign entitlements deriving from government action, including endorsement of rights (such as job property rights and ownership of land), market rules (such as eminent domain laws, and recognition of corporations as legal entities), government spending (such as transfers and purchases), and effective enforcement of these (Schon; Wellford; Schmid 1987), and the implied incidence of transactions costs which arises from the distribution of rights under interdependence. Economic power helps assign entitlements occurring from bargaining and exchange, by influencing the strength of the respective parties (the economically powerful longshoremen, for example, through bargaining were able to force entitlements to a share of the benefits or compensation for prospective losses from technological change, while economically weak migrant labor harvesting tomatoes were not). Administrative power, inherently localized within organizations, helps assign claims conflicting within individual organizations.

There are often underlying justifications for entitlements, helping focus debate about which conflicting claims should be endorsed, and providing a legitimacy for presently recognized claims. These justifications can be concepts of justice (Rawls; Varian 1975; Kearl 1977; Dick 1975), custom, contribution, trade (issue of exchange rights), status, or others.[14]

Actual entitlements need not be consistent with the justifications, in that they can differ widely from the rhetorical facade used to gain public acceptance. Strategic behavior or subsidized information (Bartlett) can be used to alter or defend entitlements in favor of certain groups or individuals, as intense political lobbying demonstrates.[15]

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[14]Including achievement, productivity, honorific status, sacrifice, deprivation, and functional role (Samuels 1982b p. 6).

[15]For an agricultural example relating to farmer organizations and commodity support programs, see Fuller 1969.

Economic analysis can be part of this rhetoric to justify entitlements, whether positively or normatively.[16]

Four general aspects of entitlements demand further attention, though this should not distract from the central thesis that entitlements derive from interaction between the types of underlying situational interdependence and the rules of order. Contribution is a frequent justification for a claim on income, but inherently involves several issues of public choice. Grants arising from government action frequently are explicit entitlements, relatively easier to discern than others. Public perceptions of fairness serve to protect some claims through threat of retaliation. The exchangeability of entitlements is important for their value.

[16]Productivity theories and exploitation theories, for example, take one favored conception as the base of analysis and then use the resulting analysis to justify that original base conception (Samuels 1982b).

i. Contribution

Entitlements based on contribution make the endorsement of inputs and output a vital concern.[17] Endorsement involves two steps: recognition of presence, and determination that the presence obligates a claim.[18] Endorsement (i.e. a right) can occur when demands for compensation are legitimized, either through judicial action, legislative action, economic threat, or new standards of fairness. This is not a neutral process, in that endorsing a claim simultaneously influences the claims of others; it redistributes the income.

Endorsement does not follow set rules, appearing relatively arbitrary because it arises from power and norms. Air in steel production, earthworms in crop production (through soil fertility), homemakers in their spouse's professional performance, technical knowledge embedded in a

[17]Inputs and outputs here refer to those things required for production to occur in a physical sense without regard for whether these are endorsed by the system of rights. Polluted air is an output of steel production, for example, whether or not rights to the air are specified. To distinguish endorsed inputs and outputs from unendorsed (and thus hopefully avoid some confusion), the former will be called "factors" and "product," respectively. Undesired but endorsed outputs will be lumped into the "factors," because the costs of disposal are typically considered a production expense by firms. "Inputs" and "output" will usually refer to both the endorsed and unendorsed components involved in production. All inputs or outputs may not be recognized, even though they are ineluctably present in production.

[18]Recognition is dependent on the state of knowledge, in that the ability to detect presence depends upon the level of scientific skill, and on the situational interdependence and production relationships. Complementary goods have no marginal product, for example, compounding the problem.

common tool, technical knowledge embedded in a patented tool, harvest labor in blueberry production, a start-up operating loan in a neighborhood grocery, and diesel fuel used in corn production are all examples of recognized presences in production. The first four, however, do not bestow claims on output, even though they are as present in production as the latter four.

Presence of an output (input) may be detected only after production (consumption) has occurred, as with lung cancer from the use of asbestos, eagle deaths from the use of DDT, or reduction of uterine cancer from use of birth control pills. The response to this new knowledge is as subject to the same unpredictable pressures as a priori endorsement. Claims can be granted, based on this new knowledge, as is being done with asbestos, or not granted, as with the latter two. Rules can be altered because of the new knowledge, as with DDT, to prohibit production completely instead of granting new claims on production. The newly discovered presence can be merely acknowledged with resultant effects on demand or supply, without additional claims, as with birth control pills.

The specification of product is similarly important for influencing entitlements and the distribution of income. Undesired outputs, such as air pollution, impose injury whether endorsed or unendorsed. This also applies towards beneficial outputs, such as land-value appreciation. Capture of the benefits from land-value appreciation depends upon public decision (Schmid 1987 p. 134-136); because these are often not recognized as a product they are not subject to claim, and simply accrue to the owners.

ii. Government Grants

Claims on government are a form of entitlement which need to be explicitly discussed. Government entitlements such as Aid to Dependent Children, Social Security, Medicare, and commodity support programs are most frequently cited examples, but also include incidence of taxation, types of tax shelters, government spending, and other forms of government action which influence the distribution of income. Besides the enforcement effects alluded to earlier, the political power behind the creation and continuance of each program is vital, because these entitlements last only as long as the political power exists to prevent change (or to continue support for the program when the underlying legislation is sunseted). The distinction between "entitlement" and "value of entitlement" is harder to make with many government entitlements, because the value is more likely to stem from the same political power as the entitlement itself.

Change in government policy may require accommodation, either to appease social sense's of justice and/or to gain enough political consensus to effect the change. Severance pay or buyouts of individual's government created entitlements may be necessary to get the support of the individuals directly affected or the support of others. The dairy buyout of the mid 1980's, where some recipients of dairy supports agreed to forego future claims by ending dairy production in exchange for a one time payment to assuage their claims on government dairy support, are one example of such a procedure. These may not completely satisfy former recipients of government benefits, but they provide enough semblance of fairness that the political power can be accumulated to change programs.

These buyouts of claim similarly operate with non-governmental entitlements, as with corporate employment. Severance pay or golden parachutes offer enough assurance of employer fairness that covered employees will respond in kind.[19]

iii. Fairness

By fairness entitlements I refer to those entitlements supported through norms, without legislation or enforcement.[20] Kahneman, Knetsch and Thaler (1986) claim that rules of fairness govern market behavior, even though these rules are not overtly legislated. Firms, for example, usually do not

[19]Likewise, noncovered employees may resent the parachutes, and have less loyalty because of them.

[20]This can be confusing, because legislative and judicial choices are made and supported by conceptions of fairness. I refer here to internalized standards without formal establishment.

violate community standards of fairness, even though such transgression would maximize profits. A firm usually will not lower its employees' wages simply because growing regional unemployment has decreased the wages necessary to hire new workers. Experiments suggest that consumers do consider firm fairness, and are willing to punish unfair firms by not transacting with them even if this has costs for the consumer (pp. 736-737), providing a measure of enforcement to these entitlements.

Kahneman et al. suggest that "Dual Entitlements" exist via informal, not legislated community standards of fairness, which state that one person cannot gain by simply imposing an equivalent loss on another. Transactors have an entitlement to the terms of a "reference transaction" and firms are entitled to their "reference profit." These "references" are relevant precedents, such as market prices, posted prices, and the history of previous transactions between a firm and a transactor. Because the specific transaction taken as a reference can vary between individuals, disagreements can arise even with agreement on principles of fairness (p. 730).

iv. Exchange Rights

The transferability of entitlements affects who can acquire them as well as their value. With exchange, the original grantee of an entitlement may transfer it to another actor. This ability in itself is an entitlement: "the right to transfer is the right to create costs for the parties not represented in the market (that is, it is the right to create costs for others, which are protected in no other way than by prevention of marketability)" (Schmid 1987 p. 145). The rules of exchange and relative bargaining strengths within these rules thus affects who holds the entitlement.

Exchange rights also influence the value of entitlements, according to Schmid, by permitting the possessor to claim future use values as well as present consumption. The capitalization allowed under exchange rights is fundamentally different from non-exchange rights, in that "in a system of nontransferable use rights, one must stick around if one is going to capture any (future output)... But in a system of exchange rights, one can cash in one's claim, extract a present value of the future output, and leave for other activities" (Schmid 1987 p. 147). This is highly important when considering entitlements from agriculture and productivity change.

c. Compensation

Demands for compensation arise when a potential claimant protests that an act (or lack of action) involved a "taking" of their entitlement or value of such entitlement which at present does not, but should, bestow a claim. This can occur either because the taking is not explicitly recognized by the institutional structure, or because enforcement difficulties limit the ability of a recognized claimant to acquire their due under the rules of order.

In a world of interdependence, actors inevitably and unavoidably impose injuries and benefits upon all other actors. Takings are ubiquitous, but because the legal process "cannot always compensate for injury ...the problem becomes one as to when and to whom should compensation be paid"[21] (Samuels 1981 p. 73), or which injuries are merely "bad luck" and which are "damage." Uncompensated injuries are inevitable, making it impossible to formulate a rule to compensate for all losses (Samuels & Mercuro 1979 p. 159).

Entitlements are the status quo demarcation of which takings are remunerable, decisions made prior to the action. Compensation is a dynamic in the creation or destruction of these entitlements:

> There is, then, an ultimate necessity of choice as to who will have what rights and who will be exposed to the exercise of the rights of others and in what way or within what limits, that is, who will have what capacity to act and to inflict gains and losses on others. The cloud of ambiguity is partially lifted in each court case as conflicting claims are weighed and one interest is made to yield to the other. The process of determining compensability is one such mode of creating and destroying rights.
>
> (Samuels & Mercuro 1979 p. 173)

[21]Emphasis in original.

Aggrieved actors can respond to their unsatisfied claims in two ways: by demanding compensation for their injury, or by seeking injunctive relief from the injury-causing action. The entitlement and distributive consequences are different. Compensation provides some remuneration for the perceived damage, granting the recipient claim due to injury and an obligation on transgressors to respect those claims. It does not grant the recipient the right to avoid injury, but only the ability to receive reimbursement for injuries which occur. A transgressor keeps the right to inflict this injury on others, needing only provide the adjudicated compensation if they choose to inflict the injury. Injunctive relief grants the recipient the right to avoid the discussed injury entirely, while denying transgressors the right to inflict such injury. The distributive impacts of these are clearly different.

Whether injuries resulting from a change of technical relationships, including changes in the value of immobile assets and displacement, receive compensation depends upon perception of the change and the determination of rights. If the change is perceived as abrogating a contract, compensation can occur even when other property rights have not been violated. This can include perceived implicit contracts, as with farm income and price supports. If property rights have been abridged, a compensable taking may have occurred as well.

Payment of compensation can arise from government order (judicial or legislative) or threat. Judicial interpretations of what constitutes a compensable taking under the rules of the nation are common place. Legislative actions can similarly compel compensation by altering the rules to define the discussed action as a taking. Threats can also compel compensation, especially when they involve actions with the potential for high costs with little chance for redress. The potential of strikes and work stoppages by the International Longshoremen which could impose costs on warehouses and ports adopting labor saving technology likely helped inspire the offer of compensation to displaced workers.[22] Conversely, one likely reason migrant workers displaced by the mechanical tomato harvester did not receive offers for compensation was their inability to threaten effectively those adopting the harvesters.

The transactions costs involved are important for influencing which actors can demand (and receive) compensation, as well as the method they choose for seeking compensation. The incidence of these costs can be a barrier to those seeking redress or protection to those attempting to

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[22]Effective threats because the acts are either not illegal in and of themselves, or are hard to detect because of large policing costs. Threats like burning buildings or machines are not as effective for achieving compensation because they are illegal, giving the target good alternatives to paying compensation. Threats intended to discourage adoption are another matter entirely, similar to injunctive relief.

avoid paying compensation, effectively favoring the interest of those who face lower costs in organizing similarly concerned parties, acquiring information on the actions of others, and influencing decision makers.

Relative bargaining power is important, as the different outcomes with the longshoremen and migrant tomato pickers demonstrates. Judicial appeal requires different transactions costs, and is more accessible to the relatively powerless (both economically and politically) than formal appeal to legislative decision makers. Legislative appeals, ostensibly to change rules or enforcement, are only effective for those powerful enough to influence decision makers, including paying the transactions costs involved.

2. Method of Production

A second general type of choice is about which production method (for a given good) an actor will use if they desire to produce. This choice is between the possibilities known under the current state of knowledge, constrained within the limitations dictated by the institutional structure and by the state of knowledge: if the individual, for example, does not have access to the resources necessary for one of the possibilities,[23] that possibility is not an option. It is a choice from between the known and accessible alternatives.

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[23]Required for acquisition of the method as well as effective use of the method.

The state of knowledge at any point in time specifies the alternative methods for producing a given good.[24] Individuals wishing to produce choose a production method from among these possibilities. Each alternative carries concomitant requirements for a set of inputs, differing either in proportion or content. The prior choices of order in the market delineate which of these inputs are endorsed, the entitlements relating to the inputs and outputs, access to, and methods of acquiring these resources (including knowledge of production methods). This influences who can choose which production options and helps demarcate supply and demand.

Individuals choosing a method may not be aware of all the available options under the current state of knowledge because of the information costs associated with learning what is available.[25] The information costs are above and beyond the costs of acquiring the knowledge necessary to put a method choice into practice (such as patent licensing, working around a patent, or developing the skills needed for a chosen method). The information costs are relatively risky investments, because there is no guarantee that the available

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[24]This should not be misunderstood to refer to alternative points along a production isoquant.

[25]Research and development costs are different from these information costs, because research and development attempts to create an entirely new previously unknown method, not simply see what options are currently available.

methods discovered through expenditure will be more attractive than the methods already known.

The methods known will vary between actors, depending upon their willingness (and ability) to pay information costs and take the risks. Those with few resources (or small output) may not have the ability to risk the expense of learning of alternatives, in part because these information costs would be a larger proportion of their total costs and because they likely would be less able to successfully adopt many of the learned options because of their resource constraints. They will stick with the relatively well known options, even though better (but less well known) options may exist.

Those with relatively greater resources (or greater output) have a greater ability to risk information costs because the costs are proportionally less of their overall business expenses and because their abundance of resources increases the opportunity to take advantage of learned methods. They can also take advantage of economies of scale in information acquisition.

The basis of choice between alternative methods are the expected benefits of each method to the chooser compared to the chooser's expected costs. Uncertainty and risk are important in these deliberations, because they affect the perception of relative benefits and costs. The uncertainty includes expectations about future demand, supply, costs of production, and benefits. Information can reduce the risks but is neither free nor perfect. The actual benefits and costs are a function of which inputs are endorsed, entitlements, rules of exchange and access, and the relative values of the factors and product which arise within this institutional context. The consequences of method choice must yield competitive production costs (costs < revenues) or the actor will eventually be forced to either change to a less expensive (under the institutional context) method or to quit production.

The irreversibility of some investments increases the risks of choosing a method. Selecting a method requiring immobile assets makes changing methods later more costly because the immobile investments would have to be foregone. The risks associated with choosing an "immobile" method are thus greater than with non-"immobile" methods, increasing the importance of information costs and uncertainty. Incorrect expectations can be costly.

Selecting an "immobile" method makes an actor more dependent upon others actions, because it increases the potential harm from changes in the supply of required inputs or demand for product. Disruption of either input supply or product demand not only means loss of ability to produce under that method but also a loss of the investments, making change to new methods more costly. The immobility gives economic power to the suppliers of inputs and demanders of output because their threats to withhold carry more potential damage than if the producer could change without investment loss to a method less dependent on the withheld input or producing a different good.

The choice of production method[26] is individual, but within the constraint of others' choices. The choices are thus interdependent. If economies of scale are involved in the production or provision of inputs, the comparative advantage of a chosen method will be influenced by the quantity of the input demanded, a function of the input's different relative importance in the available methods and the amount of product produced with those various methods. If an economies of scale influenced input is used in only one method, for example, the comparative advantage of that method with respect to other methods will depend upon the quantity of product produced with that method and thus the level of demand for the input. The pricing rules for the inputs are also highly important, because they influence how the factor price responds to changes in derived demand.

If the method or an essential input is a preemptive joint impact good, <u>who</u> chooses makes a difference. Choice can be preemptive even if the goods involved are incompatible-use, especially when market coordination is important. A handling system compatible with only one method (or subset of methods),

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[26]Including a decision not to produce.

such as box beef, pallet sizes, or bulk bin handling of processing tomatoes, precludes change or choice of other incompatible methods.

If necessary inputs are incompatible-use goods, the supply decisions of owners are important, especially if the method involves immobile assets. The price of factors in limited supply depends upon the derived demand, and access to them depends upon ownership and exchange rules. Natural monopoly prevents others from using the factor unless the owner agrees, unlikely if the owner decides to use the input herself.

The ownership of required goods, as well as the means of acquiring access (such as exchange rules) to those inputs, are also important influences on the comparative advantage of methods because of the transactions costs involved. These costs can limit the options available to some because of the distribution of ownership. Vertically integrated firms, for example, are sometimes competitively dominant simply because their ownership of the stages of production reduces transactions costs and risk, allowing them to choose a method not effectively available to others.

The competitive advantage of a method obviously also depends upon the methods others have chosen (even without regard for economies of scale). If under today's economic conditions a farmer chooses to produce corn with draft horses instead of tractors, for example, his competitiveness depends upon the method choices of other farmers producing corn (and consumers' substitutes for corn). If all other farmers choose to use tractors the draft horse method likely will not be very competitive. If they all choose, however, to use hoes his choice will be most competitive.[27]

An individual's choice of method is not wholly independent. The relative attractiveness of methods depends upon supply and demand, a function of the situational interdependence and choices of order, including decisions determining who can influence whom, access to information about available options and the future access to the resources needed to adopt and use a method, and ability for consumers to express preferences. Choices of method (and relative incentives for options) only occur within this context. Choices of method themselves are interdependent through economies of scale, preemptiveness and incompatible-use, which affect the options available to actors, and transactions costs and the consequences of others' method choices, which affect the relative advantage of each method.

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[27]One problem with discussing "comparative advantage" is that it assumes an objective function or goal, such as in economic rationality. Economic returns can be the primary (or sole) objective of the method choice, but other objectives are equally possible. The draft horse farmer, for example, may be willing to forego higher possible returns with tractors because the satisfaction derived from working with the horses is greater than the opportunity costs.

3. State of Knowledge

The relater of inputs and outputs in this world is knowledge, not physics. Technology is inseparable from the knowledge embedded within it (Ayres 1978 p. XV; Brinkman 1986 p. 338; Neale 1984 p. 575; Shaffer 1969 p. 260). As human understanding of the physical world increases, new methods of relating inputs and outputs are discovered, allowing productivity change to occur. The state of knowledge at any point in time specifies the alternative methods of production available. These are the alternative methods actors must decide between during choices of method.

The state of knowledge is important for economic performance because it provides the methods of production available, and when combined with the prior choices of order (and situational interdependence) helps designate the interdependence between actors necessary for production to occur. This technical interdependence arises directly from the knowledge of possible physical relationships and the access to and control of those inputs mandated by the market's institutional structure. These dictate which inputs are needed with a given production method, which of these inputs are endorsed by the system of rights, and the methods of acquiring them: essentially who must deal with whom for production to occur.

Technical interdependence does not specify the types of interaction which must occur, only that effective controllers of iron ore, for example, are more dependent on effective controllers of coal than on effective controllers of wheat flour when production of steel is desired. Unlike situational interdependence which is unchangeable because it is inherent in goods, technical interdependence is alterable as the state of knowledge and/or the adjudication of situational interdependence (order) changes.

Knowledge itself is a joint impact good, in that the cost (besides the expense of learning) to marginal users is zero. Rights to it (and to exclude others from it) are important. Ownership of knowledge can be specified, as with patents, trade secrets, or trademarks, with the effectiveness of the formal entitlement dependent in part upon the nature of the policing costs of excluding others from the knowledge. Patents on the knowledge embedded in a seed variety may have much different entitlements than patents on the knowledge embedded in chemicals or mechanical technology, for example, in part because of the different exclusion costs (Schmid 1985; Stallman & Schmid 1987).

Changes in the state of knowledge offer new alternatives for production, arising as human understanding of physical relationships changes. Knowledge can be increased through minor learning processes (Nadiri 1970 p. 1148; Parker 1982; Rosenberg 1975; 1976 p. 66; Vincenti 1984) or research and development. There are cumulative snowball effects of knowledge change occurring between sectors. A technological change in one sector can spur technical change in other sectors because of knowledge spinoffs. The implications of the latter long run dynamic process, as well as the long run appropriation of this accumulation, is beyond the more micro focus of this paper.

A change in the state of knowledge can add a new production alternative, affecting the demand for inputs and the supply of product, and thus the value of entitlements. A new method can dramatically decrease the importance of or need for some inputs while increasing that for others, with the resultant values and income dependent upon the shifts of supply and demand. It can also effectively force those actors who are unable to adopt the new method, and thus to remain competitive, out of production.

A change in the state of knowledge can also detect inputs or outputs where they previously were not thought to exist. As was discussed earlier during the contribution section, the response to this new knowledge can vary from granting of new claims to injunctive prohibition. The credibility of the new knowledge itself can be contested because of the economic implications. Cigarette company scientists, for example, typically dispute findings of causal connections between smoking and respiratory cancers, in part because the results do not favor their interests. Consumer groups and others embrace the same results because the results do favor their interests.

The direction of research and discoveries, and thus the state of knowledge, is a product of choice arising from the devotion of resources to research and development. This occurs within the context of the institutional structure of the market (and the situational interdependence beneath it) which influences individual abilities to expend resources in this pursuit and determines control of the results of the exertion (such as ownership of the new found knowledge). The specific "problem" researched is not wholly objective, but instead reflects individual interests. Research into mechanical harvesters, for example, reflected the concerns of growers faced with labor uncertainties, not the interests of migrant workers who were able to get higher wages because of the labor shortfalls.

Changes in knowledge have economic implications, so it is not surprising that actors attempt to influence the direction of research in their own interest. Research and development can be a conscious tool by one actor to reduce or avoid their dependence on a good another actor controls (as with the development of synthetic rubber to reduce need for natural rubber), or to increase that need (as with the development of fructose corn syrups [Mueller 1982 pp. 83-123]). The control of research is important because it affects whose interests will be favored in the choice of the physical relationships investigated. This control can arise from political or economic influence on others' research

(Hightower) or direct ownership of the research facilities or some essential element required in studies.

A good example of how ownership affects whose interests will be reflected in the problems researched is biogenetic research on plants. The potential biological changes in food crops from genetic research have great economic implications. One potential development would involve transferring the abilities to fix nitrogen and to naturally resist pests and weeds from plants with these properties into food crops naturally occurring without them. The resulting varieties would contain their own natural fertilizers, pesticides and herbicides, reducing the need for artificial applications of chemicals. A second possible development would transfer natural resistance to artificial chemicals into the food crops, allowing farmers to increase the level of chemical application to more completely eradicate pests and weeds without adversely affecting the desired crops. The former approach reduces the need for chemicals, potentially reducing production costs by limiting use of chemicals, while the latter allows more chemicals than at present to be used, potentially reducing per unit production costs by eliminating more loss from pests and weeds.

The choice between these disparate directions of research is likely to be made by agricultural chemical companies, who have largely bought up biogenetic plant breeding companies (Matthiessen). The former path of research would reduce demand for agricultural chemicals while simultaneously reducing ground water pollution and other side effects associated with heavy chemical applications. The latter path would not threaten chemical demand, and could even allow demand to increase, with consequent effect on the environment. Clearly the choice reflects the interests of chemical companies rather than the interests of neighbors, users of threatened ground water, and others concerned about the quantity of agricultural chemicals in food and the environment.

Investments in research and development are risky because there is no guarantee that worthwhile results will occur, much less that the financiers of the research will be able to recoup their investment even if something is discovered (due to exclusion costs and rights). The high exclusion costs are one reason for publicly funded agricultural research. For some actors, however, the risks of research investment are less than the risks associated with not attempting to find alternative methods of production. Asset immobility is a function of the state of knowledge, allowing those with immobile assets to attempt to use research to create alternative methods consistent with those assets. Alternative inputs or outputs can be discovered, potentially reducing the actor's exposure to the suppliers of the inputs presently required or the present purchasers of the product. Research and development can give actors with immobile assets alternatives to simply foregoing the investment, reducing other actors' economic power.

4. Production/Consumption/Effort

After the previous decisions have specified entitlements, control of resources, the state of knowledge, and other elements of the institutional structure, the realm of supply and demand choices becomes pertinent. These include decisions of which goods to produce, which goods to consume (as well as the respective quantities), what prices to charge, effort/quality, who to sell/buy from, and other in-market choices. Actors decide on the basis of relative values, with the institutional context weighting their preferences and delimiting opportunities, and determining the relative importance of these decisions. This is the level of choices studied in Neoclassical and production economic analyses, and of the relationships highlighted by Marginal Productivity Theory in chapter 2.

The interaction of individuals' decisions gives rise to market prices. This need not be either a Walrasian[28] (supply=demand) or Marshallian (rationing) equilibrium, in that actors can have incentives to change behaviors (either to correct their mistakes or to take strategic risks). The relative values from the market interactions feed back on the earlier

[28]The equilibrium assumed in Marginal Productivity Theory.

choices of order, method and knowledge, providing incentives to change rules, increase (decrease) access to a resource, change production method, or devote resources to exploring new states of knowledge, as well as feeding back on consumption and production decisions themselves.

The quality of inputs, such as labor, which are variable and whose quality is hard to detect, are also chosen by their suppliers within this context of relative wages and order. The institutional structure, including the incidence of enforcement costs, information costs, exclusion costs, and entitlements, as well as the level of unemployment, influence the quality of worker effort. Wages within this context affect productivity through mechanisms such as shirking, labor turnover, and feelings of fairness (Leibenstein; Stiglitz 1987 p. 20-22). Similarly, "it has long been recognized that increasing the share provided to the tenant worker could have beneficial effect on his work incentives, and thus could actually increase the receipts of the landlord" (Stiglitz 1987 p. 23).

This does not mean supply and demand are unimportant, only that supply and demand work <u>within</u> a context of other choices. After entitlements (and other elements of order) have been specified and the methods of production chosen (from within the known and available possibilities), the interaction of participants in the market work out the resulting price and quantity unique to that framework. If entitlements or the state of knowledge changes, the process equating supply and demand again works out prices and quantities endemic to the new circumstances.[29]

5. Means of Choice

The resolution of these choices arises from the interaction of individuals' decisions, weighted by a rich milieu of complexities. Of particular interest is what enables actors to express their preferences, and how these interests are weighted to reach a conclusion, not simply how people decide which option to choose. Modeling this process is beyond the scope of this paper because the resolution of choice depends too much on the specifics of each particular case, including the relative power of the actors, interdependencies, structure of rules, the specific goods involved, the actors' past interactions and personalities, and vagaries of the political process.

Describing the resolution in careful detail, including elucidation of mechanisms of power and the state, would be most important if the concern of this study was explaining the origin of entitlements and other bulwarks of institutional structure. Fortunately, the present focus on how entitlements and productivity change affect the distribution of income does not require as explicit or fully developed a theory of the

[29]As mentioned previously, efficiency is unique to this level as well (Lang; Shaffer 1985; Schmid 1987).

state and power. Mere familiarity with the role (and the importance) of power, as well as its manifestations, are sufficient to provide insight into the problem.

Choice in Neoclassical theories is constrained by scarcity: preferences are weighted by the value of endowments within that scarcity. But endowments and scarcity are products of the institutional structure, and thus of choice. They arise from the adjudication of interdependence, not preceding it, meaning that scarcity cannot be the entire answer to the puzzle. Power must be important, at least with regard to the creation of the institutional structure.

This does not reduce all choices merely to an exercise in power, an action Pen says stretches power into all-embracing meaninglessness,[30] because power is constrained. DeGregori's assertion that resources "become" (a process dependent upon power through knowledge and human organization) does not imply this slippery slope because he recognizes that resources "becoming" is a long run process, with physical resource constraints at least in the short run. "Obviously, at any given time, with a given technology, there is a sense in which resources are fixed and finite" (DeGregori 1986 p. 465). Scarcity will always be a constraint.

[30]"When the world is governed by power and by nothing else, traditional economics might as well be abolished" (Pen 1978 p. 335).

This means that though scarcity is a product of the institutional structure and hence of power, allocative decisions still must work within physical limitations dictated by the state of knowledge. Therefore power cannot be entirely sovereign. It also is constrained in the long run by the speed with which human understanding of the physical world can change.

Further mitigating this reductionism is the existence of transactions costs and uncertainty associated with the exercise of power. There is expense associated with exerting power and an inherent riskiness (because of the morass of complexities some uncertainty about the prospective end results will always be present). Unless the prospective benefits outweigh the costs and risks involved with attempting to achieve a desired end, power will not be directly used to effectuate an end. Within a range of prospective payoffs[31] actors will not resort to direct exercises of power to influence market results.[32]

Power is vital for sustaining and changing the institutional structure of markets. It "is necessary to make each kind of system run: it is a combination of responsibility and the capacity to coordinate and concentrate resources and

[31]The range of forebearance will increase with higher transactions costs or greater uncertainty.

[32]The market still reflects the structure of power, in that rules reflect past exercises of power, even though power may not be explicitly exercised at every moment.

foresee dangers and opportunities" (Kanel 1974 p. 834). Pen suggests there are three relevant kinds of power (defined by their sanctions and not outcomes):[33] political power, economic power, and administrative power (1978 p. 336). Political power is that power exerted by governments, but including power exerted by pressure groups, political parties, voters, and others on government (p. 337). Economic power consists "of the power of withholding a marketable good or service, including labor, that the opponent wants. The sanction lies in the damage inflicted upon the weak party..." (p. 338). Administrative power is exercised within organizations, differing from economic power in that "the goods or services which are threatened to be withheld are not marketable" (p. 339). These include promotions, recognition, or being fired, as well as ability to decide internal organization and behavior.

a. Political Power

Central to political power is the structure of the state, including the roles of government, its operation, and how it

[33]Economic power, for example, is power resting on economic sanctions, not necessarily power over prices, wages, resource allocation, etc. "If we were to define the concept of economic power the other way round, with the impact on economic variables as a criterion, the distinction between scarcity and power would become fuzzy. Indeed, much confusion stems from the fact that people speak of economic power when they mean to refer to power over economic variables" (Pen 1978 p. 336-337).

is influenced (including its relationship to economic power). Government is not some independent entity, but is itself a bundle of conflicting interests. The political rules influence which interests will become sovereign and be effectuated through government action. Government can never be neutral, in that its actions (or inaction) always unavoidably favor some interests at the expense of others (Seidman).

There are three governmental roles of interest. It helps create the rules of the market, through demarcation of property rights and goods, permitted (or forbidden) types of organization, pricing mechanisms, and behavior, and creation and adjudication of claims on output. Government helps structure market payoffs, through grants, subsidies, tax policies and other transfers, as well as influences the number of buyers and sellers. It also is a major actor in markets, as a purchaser of goods, seller of goods, and as an enforcer of rules.[34]

The literature suggests that actors with more at risk will pay greater attention to the actions of government (Olson 1977; Bartlett; Fuller 1969; Pope 1986). Influence depends upon organizational difficulties, including free riders and excludability, size of potential benefits from action (inaction), and transactions costs involved with knowing about

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[34]Rule enforcement also influences effective rules and payoffs.

government actions (inactions) and with influencing those actions.[35] This means political power is influenced by economic power (Bartlett; Galbraith 1973).

b. Economic Power

The corollary is that economic power is a product of political power. Economic power consists of the power of "withholding a marketable good or service... that the opponent wants" (Pen 1978 p. 338). This ability comes from technical interdependence, where the market's institutional structure (order) and state of knowledge designate the constraints about who must deal with whom for production to occur. Both this structure and knowledge are influenced by political power.

Economic power is specific between actors and to technical interdependence, not outside this relationship. The greater the dependence of one actor on another, the more economic power that second actor wields over the first. This power is reduced by the existence of substitutes to the actor's good (both within the production method and in comparable alternative methods),[36] and the number of other

[35]Transactions costs depend, in part, on the structure of decision making. The explosion of subcommittees in Congress during the 1970's, which splintered decision making, increased the costs of knowing all governmental actions while decreasing the cost of lobbying any one aspect.

[36]Immobile assets can give economic power to others because the immobility reduces the ability to switch to an alternative method.

actors who control substitutes. Railroads, for example, were economically powerful against U.S. farmers during the late 19th century because farmers were heavily dependent upon their local railroad to get production to market. Few alternatives existed under that state of knowledge and set of values, rendering railroad threats of withholding service (or of asking for higher rates) unavoidable and thus very potent. The railroads were not powerful, however, against Gustavus Swift and his "unpopular" innovation of shipping processed meat because one railroad agreed to haul his freight, making other railroads' withholding less damaging.[37]

c. Administrative Power

Administrative power is power arising from threats of withholding nonmarketable things. This primarily arises within a governance structure, such as found within many market actors, and is of interest because of its influence on the internal structure and behaviors of these actors.

Organizations, such as partnerships, corporations, and cooperatives, are not monolithic sets of homogeneous interests: individuals within it have different interests, concerns, and preferences for how the organization should

[37]Williamson argued that this case was an interesting confrontation between efficiency and power, demonstrating that "efficiency ... evidently swamped the resistance of entrenched power interests" (1985 p. 237). It is a better illustration of how economic power depends upon the ability to withhold.

behave (Leibenstein 1979). The resolution of these potentially conflicting interests arises from administrative power (sometimes influenced by economic power), as expressed through (and constrained within) internal organizational rules.

B. From This Perspective

1. Productivity Change

Productivity change from this perspective can result from four major causes: reendorsement of factors, change of input quality via effort changes, adoption of a previously known but unutilized method of production, and adoption of a new method discovered through changes of the understanding of the physical world. The first two are direct products of entitlement change, while the latter two are indirect products. The range of origins makes it difficult to generalize about productivity change as well as create numeraires for comparison.

Alteration of endorsements (or entitlements) can change the productivity of existing methods by recognizing an always required but formerly ignored input (or stopping endorsement of a formerly recognized input) and thus altering the ratio of factors to product. Unrecognized inputs can later be endorsed and explicitly assigned to production in some manner, as is done with creation of worker compensation programs, and odors in livestock production in Michigan, or the technique or good prohibited because of these effects, as was done with DDT.

Input quality can vary with incentives (Stiglitz 1987; Thurow 1984), making productivity dependent upon the remuneration and other incentives under a given institutional structure. This incentive effect lies behind the concern with the relation of efficiency and equity. The effort of workers and other inputs can vary with entitlements, usually (but not always) increasing with larger relative claims on output or lower enforcement costs.

Shifts to a previously known but unutilized method change the productivity of production, with the size of change dependent upon the physical relationship of inputs and the endorsement of resources. New methods of production may not be any more productive (inputs/output) but appear more efficient to the entrepreneur (factors/product) if an increased percentage of inputs in the new method are not endorsed compared to the old. This means the pecuniary value of factors the entrepreneur is responsible for going into production declines relative to the value coming out. Clearly efficiency here is a matter of perspective and is unique to the structure of rights. Changes in the understanding of the physical world, either in the relationship of inputs or in the quality of an input, produce similar productivity changes when adopted.

Entitlements play an important and unavoidable indirect role in productivity change from shifts and new knowledge, by endorsing factors and product.[38] Productivity is an outgrowth of entitlements, which define the relevant outputs and inputs, not something existing separate from human order. All inputs and output in a production method may not be recognizable, much less endorsable, rendering productivity a judgment from endorsement and human perception, not entirely from a "self existing" physical world. Entitlements must precede productivity, both to structure incentives and to endorse factors and product.

2. Distributive Impact

The distributive impact of change is a product of choice and of power, as effectuated through entitlements to the world and the direction and size of change. Choice is constrained within scarcity and the structure of power. This process is not necessarily a zero sum game, in that it simultaneously involves the size of the pie as well as the shares.[39] The importance of choice necessitates directly including the institutional structure, which helps adjudicate who can choose, into the distribution analysis.

[38]Not to mention the vital role in supply, demand and prices by weighting preferences.

[39]It also is not an efficiency-equity tradeoff, in that both are unique to the institutional structure (Kelsey 1987).

Because of interdependence, change always has an element of injury as well as benefit: the shift to tractors in agricultural production hurt draft horse breeders while helping industrial workers, petroleum companies, and others, while the Salk Polio vaccine reduced the income opportunities of health care workers, rehabilitation specialists, and orthopedic manufacturers who provided care to those stricken. The injury from change may appear small (even trite) compared to the benefits, but the perspective matters.

The issue that arises is <u>whose</u> preferences are endorsed by change and whose are not. The direction of change in this context is not simply a process of "efficiency" overcoming "inefficiency," but whose preferences have been affirmed by (or expressed within) the choice process. This implies that choice, not the direction of change, is inevitable.

Decisions between conflicting interests, such as between market rules of order, are made through power, not through relative prices. Elements of the institutional framework resolving interdependencies, including control of resources, endorsement of factors and product, and the demarcation between compensable and uncompensable injuries, the state of knowledge, and choices of method all influence relative opportunities and values, and thus market performance. Reaction to an innovation can be injunctive efforts to prevent adoption by establishing (or explicitly recognizing) different rights,[40] as well as mere adoption and adjustment.

Explaining the distributive impact requires explaining two related elements: the level and direction of change, and the division of benefits and costs. The level and direction of change directly involves relative prices, research and development, effort, and the institutional structure influencing who can choose. Division includes claims on the income changes, ability to adopt, individual costs of adoption, and social costs of change. The level and direction, and division are intertwined, mutually influential. Discussion requires their artificial separation.

a. Level and Direction of Change

Induced Innovation and other theories suggest that the direction of productivity change is made on the basis of relative prices without regard for power. But, as previously discussed, prices are unique to the underlying institutional structure that helps structure which opportunities are possible and weights preferences, playing a key role in determining the favorableness of alternatives. Choices of

[40]Production of mechanically deboned meat (MDM) was prevented by an injunction sought by consumer groups (McNiel). With MDM, consumers' right to be free from potentially dangerous but undetectable substances conflicted with sellers' rights to sell a product and consumers' rights to choose these substances if they so desire. The courts ruled that the former rights had precedence.

method, production and consumption conform to relative values, but the origin of these values is a product of choice and power, and is not inevitable.

This arises directly in the ability to create new alternatives (choose the state of knowledge), as well as indirectly through the formulation of relative prices (influencing which alternatives appear worthwhile).

i. Ability to Create New Alternatives

Creating a heretofore unknown method of production (either producing a familiar product with new inputs, or a new product with known factors) is an important competitive market strategy. New products can proffer great economic benefit, as Xerox technology or Polaroid photography demonstrate. Similarly, discovering a different method of producing a known product can alter the distribution of income by reducing the demand for previously required but now less important inputs (including patented knowledge of "old" production methods), or increasing demand for other inputs (including patented knowledge of the new method[41]).

The financing of R & D is very important because this is where one of the biggest (and most invisible) choice is made between different possibilities. Grants, direct funding, and other sources of financing help determine which possibilities

[41]One justification for patent laws.

are explored, and which are relatively ignored. Even small grants can influence the direction of research programs spending far more money (Hightower 1973; Marion 1988). Scale advantages, whether informational (Bartlett) or from production volume, further influence which individuals are able to create alternatives.

The incentives from entitlements influence the type of change investigated. Beneficial production methods will not be explored without there being a possibility of recooping incurred expenses, no matter the extent of potential productivity change. This explains the emphasis on hybrid seeds by plant breeders, even though open pollinated plants are not necessarily less productive (Berlan). What will be explored depends, in part, on the effectiveness with which the developers can capture benefits.

ii. Relative Prices

Prices are unique to the institutional framework of rules, entitlements, compensation, preferences and effort, and hence to the choices of order, knowledge, method, and consumption and production. If the choice between alternatives is economic, as suggested by Induced Innovation Theory, the relative attractiveness of alternatives (as well as ability to choose) will depend upon these prior choices. Relative price changes can occur from changed preferences, changes in the supply of factors or product, changes in the endorsement or control of resources, or changes in entitlements or grants. Individual adoption choices will be made on the basis of who can demand compensation, the relative ability of these prospective claimants to force such compensation, who will have effective entitlements to benefits, who will be stuck with injuries, and so forth, as well as the physical scarcity of goods.

iii. Level of Benefits

The level of benefits is not independent of the claims on those benefits (Stiglitz 1987; Thurow 1984). The incentives for effort, both in the assignment of entitlements and level of those claims, have well recognized effects on productivity. The division of the pie is not independent of the size of that pie.

This interdependence of level and division causes problems for traditional Marginal Productivity Theory because when productivity varies with wages "the supply curve of labor varies with demand for labor" (Blaug p. 437). The independence of variables required for mathematically unique solutions is not present, requiring some explanation besides equilibrium to explain wages.

Increasing the total size of benefits available under a given status quo set of entitlements, as is frequently the intent of mainstream concern for efficiency, conceivably may result in a smaller pie than available under a new set of entitlements offering different incentives. The division cannot be separated from the level of total benefits without value judgments that the status quo entitlements are just.

b. Division of Benefits

Also important in the distributive impact of change is the division of benefits (and the corollary ability to avoid injuries). These include effective entitlements resulting from the interaction of interdependence, rules and enforcement, and the ability to either avoid injury or to have injury defined as compensable damage (via economic threat, or change of order from politics or judiciary), as well as access to alternatives (the ability to adopt an alternative or choose a method), the individual costs of adoption, and the market wide costs of change.

i. Access to Alternatives

Access to alternatives is important because it influences who is able to adopt a method (as well as the costs of adoption). The crucial question is whether the alternative is possible for the individual (as well as the option not to adopt and still produce with the old method). Access can be limited via patents or trade secrets, joint impact goods (whether through the goods themselves or the coordination mechanisms), or the resources requisite for adoption (both scale differences and rights to the resources).

In a world of imperfect information, the information costs of finding alternatives already known by others can be an important influence on access: those with ability to pay information costs will tend to have more options than those unable to search. Scale requirements of alternatives may further limit access, particularly with volume, financial, or skill requirements.

ii. Cost of Adoption (Individual)

Related to access is the concern for the individual's costs of adoption, in particular whether it is advantageous for the individual to adopt an alternative. The resolution of the situational interdependencies inherent in necessary resources (inputs and outputs) help determine the costs of requisite goods by influencing demand, supply, and the methods of acquisition.[42] The relative immobility of current assets (skills, machines and biology) and their potential usefulness in the new method is of similar concern, especially when compared to potential benefits of change. The use of endorsed inputs and opportunity costs are borne by the individual, while the cost of using unendorsed inputs falls upon those who have rights to them.

[42]Rights can be altered to prevent change (like the injunction on mechanically deboned meat) or to shift the distribution of costs to allow change (like the congressional reassignment of liability with nuclear power).

iii. Market wide Costs of Change (and who pays them)

The costs (size and incidence) of change are fourfold: the R & D costs, expense of developing needed coordination mechanisms, compensation for "damage," and uncompensated injury. These comprise the distribution of effects, and influence the direction of research as well as the access to alternatives and the individual costs of adoption.

The incidence of R & D costs can influence the direction of research, as well as the more obvious distributive effects. If a firm likely cannot recapture research costs, either through inapplicability of patents, enforceability problems, or other difficulty, private research will likely not occur. The difficulty of enforcing plant patents, for example, provided incentives to plant breeders to focus research on hybrids, which contain some natural enforcement mechanisms[43] (Berlan; Schmid 1985; Stallman & Schmid 1987). Open pollinated seed research primarily has been the province of public research.

With methods which require a high degree of coordination (or complementary goods), such as frozen food, box beef, pallet sizes, or bulk bin tomato processing, without which the innovation cannot be successfully adopted, the incidence of coordination costs is equally important. These are not

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[43]The inferiority of second generation seeds reduces the incentive to save seed, thus insuring that farmers will purchase new seed every crop year.

necessarily paid by the benefiting groups, even though they are essential (if not indispensible) for economic success.

The injuries from change, arising from the milieu of individual choice and the decisions of others (who was able to do what), fed through the market via supply and demand, and conveyed via prices and asset values, are similarly important. Which of these injuries are deemed compensable damage and which are not obviously affects the distribution of costs, and thus of relative prices.

Gustavus Swift's innovative shipping of processed beef (instead of meat on the hoof) was successful, in part, because he had access to the innovation, his adoption costs were relatively small, and the structure of rights did not assign him the major costs of change. There were significant adoption costs, including construction of refrigerated rail cars, ice houses, processing plants, and refrigerated storage houses, but he had the resources to assuage them. These were individual costs under the market order. He did not have to develop other more expensive requisite coordination and handling mechanisms (though he paid for the services of some of these) without which the packing innovation would have been impossible. These avoided expenses included purchasing right of ways,[44] laying track, procuring and operating engines, starting retail outlets, and other ancillary factors.

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[44]The contractual costs as well as the cost of the right of way.

The major injuries of adoption, the decline in asset values of the railroads owning large fleets of stock cars, processing firms with plants located in the east, and displacement of employees, were not compensable under the structure of rights. Furthermore, these affected individuals were unable to force compensation or forestall adoption through coercion because they had no effective threat; the Eastern Trunk Line Association's refusal to carry Swift's cars was ineffective even though Swift needed rail transportation, because the Grand Trunk Railroad agreed to provide this service. The change in asset values and displacement were thus absorbed by the individual owners, even though they arose directly from Swift's action.

If the structure of rights had been different, with job and asset entitlements, for example, which required compensation for such takings, or if Swift had to build all the coordination mechanisms (his own railroad, retail shops, etc) the adoption likely would not have occurred.

C. Analysis with the Framework

The framework developed here offers a conceptualization of market behavior which moves beyond concern for supply and demand, to encompass the institutional complexities which give definition to supply and demand as well as comprise the primary realm of policy actions. It can be used to structure a more complex story of productivity change than those strictly with the assumptions of Neoclassical theory, offering additional insights and explanation of the process of change.

The relative importance of different variables suggested by the framework depends, in part, upon the specific case under study. These are meant as general things to look for in understanding the case, instead of as a rigid model to interpret empirical observations. It is not intended to be deductive. The general variables offered here must be uniquely applied to each specific case because they are meant as possibilities to consider instead of categories which must be present in every situation.

This framework does not escape the subjectivity of analysis present in the approaches reviewed earlier. The methodological and theoretical decisions which frame it still reflect "pre-scientific" judgments, and implicitly favor some interests over others. The approach is not arbitrary because it is consistent with experience and evidence, Polanyi's bench mark for scientific knowledge (p. 66). It is, however, no more "truthful" than other scientific approaches (such as Neoclassical) because it unavoidably reflects its underlying paradigm. Its "truthfulness" depends upon acceptance or rejection of its paradigm, a nonscientific judgment, not wholly on scientific rigor.

This general paradigm or approach is appropriate for economists and others who believe that the institutional influences on economic behavior and performance are fair game for analysis, as well as those who believe policy analysis needs to highlight a wider range of responses (even if they are not acted upon) than those perceived by analysis focused purely on in-market behaviors.

D. Summary

The Entitlement and Productivity framework is premised on the conceptualization that markets are sets of rules and regulations adjudicating conflict. The conflict arises because actors are interdependent, with the choices of each person constraining the opportunities of other people. The types of interdependence, and thus conflict requiring adjudication, can be characterized by those inherent in the goods involved (situational interdependence), and those from the interaction of possible methods and the effective control of goods granted by the market's institutional structure (technical interdependence). The resolution of situational interdependence through market rules provides the effective control of goods, which when combined with the alternative methods of production determines who must deal with whom for production to occur.

This context provides the opportunities and constraints faced by actors (including claims on income), within which they make their choices of production method, level of production, level of consumption, and effort. It also provides the incentives for changes in technology, institutions, biology, or human skills. Traditional economic analysis falls within this context, taking the prior decisions about situational interdependence and available methods as exogenous.

Recognition of the role of the institutional context makes it clear that actors have choices beyond production and consumption that can influence their income. Actors can change the market rules to redefine who can participate (and how), changing the number of competitors or suppliers. Rule changes can be done to alter the definition of factors or product to receive compensation for some taking, to allow themselves to take from others without paying compensation, or to change the legality of a particular production method. They can change the state of knowledge to create a new competitive production method either more dependent upon factors with entitlements they hold or an input not requiring remuneration for use under the status quo order, or less dependent upon an input or factor to which they do not have ready access or control. They can switch to an alternative (but already known) method for similar reasons.

These actions are reflected through the interaction of supply and demand, which determines the actual value of costs and benefits from the action. Focus entirely upon supply and demand or relative prices during analysis, however, misses the influential and dynamic role of these choices because supply, demand, and relative prices only have meaning within this context of prior institutional choice.

The general categories of choice involved with the distribution of income from productivity change can be divided into four types. Choices of order are the choices which designate market rules and interact with the situational interdependences present to create the effective entitlements in the economy. Choices of the state of knowledge are research and development choices intended to change human understanding of physical relationships, discovering either new methods of producing a given good or methods to produce an entirely new good. Choices of method are the choices by actors about which of the alternative methods of production available under the current state of knowledge they will use to produce a given good. Production, consumption and effort choices are actors' decisions of how much to produce and consume typically considered in traditional analysis, as well as the choice of work effort. The fourth category falls within the context of the prior three, but feeds back on the context through the relative prices which result. This is a dynamic interaction, not mutually exclusive, but each category needs to be considered separately.

1. Choices of Order

The choices of order are the combination of rules and types of situational interdependence which define actors, product, factors, and methods of acquiring needed goods. They essentially designate who can exchange what to whom (and how). Effective entitlements (claims on streams of income) arise from choices at this level.[45]

The elements of interest for distribution analysis stem from the resolution of the situational interdependences. How the choices adjudicate the conflicts inherent in the situational interdependences present have clear distributive effect. The types of situational interdependence in the case under study indicate the institutional rules important for distribution. The rules determine whose interests are favored and whose are not.

In general these rules can include ownership of incompatible-use goods (with transactions costs this has implications for the end use of the good, as well as entitlements); excludability of the good; who decides joint impact goods, who pays for such goods, and who has access to them; level of information, contractual and policing costs; and pricing rules when demand or supply fluctuate; permitted methods of exchange (including pricing systems); rule enforcement (and who pays the policing costs); and definition of actors (legal prohibitions on organization or behavior).

[45]The value of claims may be set at this level as well if the entitlement does not rely upon supply and demand, or may be determined in the context of the other choices, through the interaction of supply and demand.

Actors' respective abilities to change entitlements are also important. The ability can arise from political power (for legislative change of rules), economic power (to coerce other actors into voluntarily exchanging entitlements), access to judicial alternatives (injunction or judicial recognition of claim), or administrative power. These abilities to change the order derive from the order.

2. Choices of State of Knowledge

The understanding of physical relationships in the world help specify the alternative methods of production known at any point in time. Changes in this understanding, whether derived through scientific research and development or serendipitous accident can offer new, previously unknown methods of production, with consequent effect on the demand for inputs or supply of product, and thus on income.

Two general distributive concerns arise: how the state of knowledge was changed, and what effective rights to that new knowledge exist. How the state was changed includes concern for the new options created, the input and output mix involved, who chose the type and direction of research, and who financed that research. The effective rights to the knowledge include the formal ownership of the new knowledge (who has legal access), the permitted methods of transferring those rights, the effective excludability of the knowledge, and the policing costs necessary to do this (as well as the incidence of the policing costs).

3. Choices of Method

Choices of method are actors' individual decisions about which method available under the current state of knowledge will be used to produce a given good. The relative attractiveness of the options depends upon the potential benefits and costs to the chooser, a function of entitlements and expected supply and demand. The method decisions must occur in expectation of (prior to) supply, demand and relative prices, with the distributive consequences depending upon their interaction with choices of production, consumption, and effort.

The relative attractiveness of options depends upon many variables, but most apparently on several: which inputs and outputs are endorsed by order, and thus require purchase or compensation for use; an actor's effective access to inputs required by a method, plus the method of acquiring the inputs (including the relative value of the input and the transactions costs necessary for acquisition); an actor's effective access to the alternative methods of production (either access to the required knowledge, inputs, or scale requirements for using the method); immobility of investments necessary for a method (makes the method riskier to use because it increases the opportunity costs of changing later);

the preemptiveness of others' choices (order of choosing, joint impact of decisions, and economies of scale for needed inputs); if the method is a legal option (and policing costs by others if it is not); the potential benefits to the chooser (expected production costs compared to costs in other methods, as well as expected price and demand for output). Many of these are not mutually exclusive.

4. Choices of Consumption, Production, and Effort

Actors make production and consumption decisions within the context of their respective opportunities granted under order, methods, and state of knowledge. These prior choices effectively weight how well actors can express their preferences, as well as determine supply by adjudicating who has effective control of inputs and outputs (as well as transactions costs involved), and thus who must be considered if production is to occur. The effective entitlements under this institutional context provide the incentives for effort.

The central interest at this level of choice are the relative values of inputs and outputs arising from the interaction, as well as the quantities of the inputs involved. Who these values accrue to depends upon effective entitlements (of which takings are recognized as requiring remuneration or compensation). The relative values provide incentives for actors to change their choices of order, knowledge and method, while simultaneously weighting actors' abilities to do so.

ENTITLEMENTS AND PRODUCTIVITY: RESEARCHING THE LEVEL AND DIVISION OF THE FRUITS OF PROGRESS

Volume II

By

Timothy Wayne Kelsey

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Chapter 5

Bovine Growth Hormone

An illustration of the role of choice and institutional influences on the distribution of benefits from change is the pending adoption of Bovine Growth Hormone (bGH).[1] It also provides a useful illustration of the entitlement and productivity framework. BGH is an interesting case because the entitlements and rights involved in the change are still being adjudicated and formed. Groups are posturing to alter the potential distribution of benefits, both because biotechnology is still a relatively new "product" and hence rights to it are not yet embedded in the status quo, and because it is clear that changes in rights will be made through government action.

Productivity change in the dairy industry may appear unique because of the type of government involvement in milk marketing, but it only differs primarily in that the distributive choices are more obvious than with change in most other industries. Entitlements in the dairy industry are more observable because the government more explicitly defines them, but entitlements to benefits in other industries are

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[1]Terminology for the hormone varies. Originally called bGH, it has now more widely become known as bST (Bovine Somatotropin). This may be a move to avoid negative public images associated with the word "hormone" (Browne p. 15). The older term, bGH, will be used in this study.

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equally a function of government action which determines whose interests count, whether consciously decided or by default (Seidman; Samuels 1982). The distributive decisions are equally present in other industries but less obvious because the property rights and entitlements were settled long ago and have become accepted as the norm.

With the dairy industry and bGH it is more apparent that decisions about order will influence distribution than in other cases where the influence of order is present but less obvious. Many of the existing analyses of bGH implicitly recognize this by looking at the distribution under alternative policies. These choices of order are not superfluous or mere "hitches" to be worked out, but the very flesh of what "efficiency" will mean and central to the performance of the economy. What is unique about the U.S. dairy industry is that it is clear that analysis cannot occur without first specifying a value judgment, something that is equally unavoidable with studies of other sectors but not always so visible.

BGH also provides an interesting perspective on technical change because adoption is poised but yet to occur. The mechanical tomato harvester studies were backward looking, as primarily will be the mechanical cucumber harvester study which follows in the next chapter. Hind sight is often better, but it can easily distort our understanding of change by minimizing or neglecting the uncertainty involved. The stru

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struggle between conflicting interests, both within the market and outside the market framework, as well as the alternative paths (minor and major) available but not chosen are too easily forgotten once the suspense of unfolding is over. The posturing by actors attempting to influence what happens as well as the consequent distribution, is more apparent at present because it is not clear what will occur.

The uncertainty associated with bGH is both a challenge and a boon, because it raises questions about predicting with an institutional model at the same time it shows just how important institutional choices are in the distribution of benefits from change. Without an underlying deductive behavioral model, predicting actors' responses is more obviously a speculative enterprise, but can encompass more possibilities and considerations than if attention was constrained by a narrow model.

A. Entitlements in the Dairy Sector

The choices of order in the dairy sector are manyfold, most apparently formally consisting of Federal Market Orders, State Market Orders, the Federal Dairy Price Support Program, dairy import restrictions, antitrust rules for cooperatives, school lunch, special milk, and other domestic and international food aid programs, and health and product quality standards (Babb 1983 p. 168). These combine with the types

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types of situational interdependence present to create the de facto entitlements to income.

The major choices of order will be examined after briefly reviewing some of the situational interdependences, and thus conflicts, which the choices resolve. The de facto entitlements arising from the interaction of interdependence and rules will then be described.

1. Situational Interdependence

The dairy industry is affected by several types of situational interdependence. These include supply fluctuations, incompatible-use goods, transactions costs, and the joint impact nature of knowledge about bGH.

Milk production is characterized by seasonal supply fluctuations because of the biology of lactation. These production fluctuations can be minimized through careful management, but not completely avoided. The perishability of milk, the inelasticities of demand, and the continuous and relatively unalterable (once lactation begins) nature of production exacerbates the effects of the seasonal fluctuations. Milk needs to be shipped off farm at least every other day and used or processed quickly, or else it will spoil. Consumer demand for fluid milk is relatively inelastic, requiring substantial price changes to significantly alter the quantity purchased. Quantities of fluid milk cannot be purchased during low price periods and save

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saved for later consumption during high price periods because of milk's perishability. Consumers must make frequent purchases. Demand for manufactured dairy products is also inelastic, but relatively less severe. Major increases in production require several year lags to raise stock to lactation age, while short run reductions are only possible through drastic measures such as dumping milk or culling herds.

The risks associated with relatively uncontrollable supply and inelastic demand are reduced by the ability to process fluid milk into a diversity of products, each with varying perishability, transportability, and intensity of demand. The fluid milk market is most remunerative, but manufactured dairy products provide the safety valve between potential fluid supply and demand.[2] The order determines whether fluid and manufactured markets are segmented, and who is able to capture the benefits of price differentiation if they are. This dynamic is an integral part of the industry.

Milk is produced across the U.S., but it bears regional characteristics, varying by size of operation, labor (family

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[2]Fluid milk must meet more stringent health and production standards than required for manufacturing grade milk, giving rise to the grade difference between Grade A and Grade B milk. Farmers choosing to produce for fluid sales must adopt the more expensive Grade A methods. The distinction between the grades is becoming less important because most Grade B producers are switching over to Grade A production, and for this reason will not be carried throughout the study even though there are different distributive impacts on each group from the rules of order.

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or hired), and reliance on farm produced inputs (Cook p. 137). The high cost of transporting milk separates fluid markets, making regional ability to meet fluid demand important. Manufactured products can be shipped for less, providing interregional and national competition for markets. Coordinating regional fluid needs with regional production while simultaneously coordinating with national manufactured product markets is necessary, or waste or breakdown will occur somewhere in the system.

The seasonal supply fluctuations require choice about pricing and capacity; if prices are based on the value of the marginal unit, prices will fluctuate widely in the face of inelastic demand. If prices instead are based on the value of the average unit, prices will be relatively more stable but still fluctuate seasonally. If stable consumer prices are desired, an "excess capacity" can be created as a cushion, but raising the question of who pays the costs of this excess capacity during the high production times, as well as the relevant geographical boundaries of the production included in calculations of capacity.

Milk and manufactured dairy products are incompatible-use goods with low exclusion costs. Ownership of the goods is the rul

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rule affecting who has entitlement to their value.[3] BGH is also an incompatible-use good with low exclusion costs.

Transactions costs are important in dairy in several ways. The information costs about product quality (presence of pathogens or other potentially harmful substances) are high because testing is necessary. Grades and standards shift the incidence of information and policing costs about quality from consumers to producers and the government. This restricts consumers' options (preventing them from choosing pathogen infested milk or of paying less for milk by accepting the risk of taking infested milk) but simultaneously lets them know more precisely what it is they are purchasing. It also makes producers pay consumers' information costs (by conforming to health and production standards). These costs presumably are passed on to consumers in the price, but because of economies of scale the per unit cost is less than if consumers bore the information cost directly.

Transactions costs also affect the competitiveness of different organizations of actors. The perishability of milk and the immobility of production assets means coordination is important, giving an advantage to those organizations of actors which minimize information costs, contracting costs,

[3]Other rules of order such as the response to supply fluctuations, pricing mechanisms, rules of exchange, and definition of actors, as well as the choices of method, knowledge and production and consumption, are important for determining the value of these entitlements.

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and policing costs. The kinds of organization allowed, as well as the ownership of goods, has implications for market performance and distribution.

BGH is an incompatible-use good, but the knowledge involved in producing bGH is a joint-impact good because the costs of marginal use is zero. Rights of exclusion are distributively important. The costs of using the bGH knowledge, however, effectively restrict the number of potential users even if others are not legally excluded (via patents), because a user must have the requisite background in biogenetics. It is not something typical farmers could produce on their own.

2. Federal Market Orders

It became apparent that under the rights existing early in the twentieth century dairy farmers were at a comparative disadvantage relative to handlers and processors. Farmers bore much of the risk from seasonal supply fluctuations; their immobile investments and the lags in production response limited their ability to adapt to changes in market conditions at the same time that they were heavily dependent upon handlers and processors to move their product. Costs of the seasonal excess capacity were absorbed by farmers in a haphazard or seemingly random fashion. Handlers and processors could simply refuse to accept the milk beyond their own needs, leaving farmers with no outlet. This threat also

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reduced the bargaining strength of farmers. Farm gate prices for milk, set at the margin, were seasonally unstable and varied widely at any point in time, reflecting which handler and processor was purchasing it. Farmers could not effectively organize to counter the bargaining strength of handlers and processors because of transactions costs and legal restrictions.

The instability was deemed harmful to consumers as well as dairy farmers, so policy makers changed the structure of rights relating to the seasonal fluctuations. Various attempts were made before the current system of Federal Market Orders were created by the Agricultural Marketing Agreement Act of 1937. The mandate was to effectuate, in the interest of consumers and producers, an orderly flow of product, with its primary innovations the classification of milk according to use, establishment of uniform minimum prices for each class, and creation of a method of distributing the proceeds for milk in all uses to producers (Christ 1980).

A reserve pool of fluid milk was formally encouraged to insure demand would be satisfied despite the supply fluctuations, at the same time a mechanism for disposing of the reserves and for remunerating farmers was created. This included pricing incentives for a reserve, price discrimination, and pooling mechanisms.

Two general farm gate prices for milk are recognized (three in Federal Market Orders with three classifications), based on use. Fluid milk prices are higher than manufacturing milk. The price formulas are based on the grade B price (manufacturing milk) in Minnesota and Wisconsin (the M-W price), the major production "surplus" region against which fluid milk diverted into manufacturing products compete. Fluid prices are based on the M-W price, but include a class I differential that considers transportation costs from the surplus region, as well as an adjustment for the higher production costs required for grade A. The classified prices serve as the minimum processors are required to pay.

This has distributive consequences because it is a form of price discrimination. Babb argues that the discrimination is inherent in the different price elasticities of demand, not a creation of market orders. An end to classified pricing would not necessarily eliminate price discrimination, but might transfer "the income gains from price discrimination... from producers to processors and/or retailers, who could practice discrimination without an order. The issue really turns on the distributional aspects of the discrimination gains" (p. 182).

The class I differential is intended, in part, to elicit the reserve pool of fluid milk necessary to handle fluctuations in supply and demand. The differential is adjusted or set to influence the size of a region's reserves. A pool of 20 percent of normal fluid needs is commonly stated as a goal. The reserve pool helps keep retail fluid prices from wi

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from wide price swings or from shortages of product, a benefit to some consumers. Reserve milk flows into fluid markets when needed, and otherwise is sold for manufacturing use.

Farm gate milk prices are a blend of the two prices. The pooling rules establish farm gate prices as the value of the average unit of milk produced instead of the value of the marginal unit, with the average based either on the value of the entire market's use (with market wide pooling) or the specific handler's use (with handler pooling). If 60 percent of grade A production goes to fluid use and 40 percent into manufacturing, for example, each farmer in that market[4] would receive a "blend" or "uniform" price reflecting that percentage breakdown.

This obviously has distributive effects because it defines the product being sold by farmers. By defining milk as a homogeneous flow rather than as specific units identified with an individual producer, each farmer's value of production is a function of the market value of the total flow of product into fluid and manufacturing uses, not a reflection of the individual's finesse or bargaining power in selling to handlers and processors producing the higher valued fluid products. This avoids a lot of the instability that would

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result if farmers had to fight[5] against each other for the more remunerative uses, as well as the high transactions costs and difficulties in coordinating supply and demand. It also makes price bargaining less important for farmers, handlers, and processors, disadvantageous for these latter two because it reduces their ability to use the disproportionate economic power they might otherwise have relative to farmers. Farmers' incentives for increasing production are also different than in many sectors, because they receive the average value instead of the marginal value of increased output.

The market orders also influenced relative bargaining power in four main ways: they injected discipline into the pricing process with clearly specified marketing procedures, minimum prices enhanced farmers' economic power,[6] the public collection and dissemination of market information led to more equal bargaining positions, and they reduced competition for milk from marginal sources at prices below the minimum (Babb p. 177).

[5]Some may be tempted to use the term "compete," but the situation would not be close to the norm of perfect competition because of farmers great inability to control production in the short run, extreme perishability of product, and high information costs. Christ says it is probable that the price enhancing effects of classified pricing brought producer prices closer to the competitive norm than before (p. 184), implying that elimination of classified pricing would reduce competition in the traditional sense.

[6]The minimum prices arose, in part, through the political power of dairy farmers.

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It is likely that Federal orders have been successful in achieving some of their goals through redefinition of rights. Retail dairy prices have increased slower than the average of all foods since 1935 (Manchester 1983 p. 215), while price and income stability has been promoted at farm and retail levels (Babb p. 176). Seasonality of production has diminished because of price plans in the market orders, reducing seasonal price instability and making it easier for handlers to dispose of milk in excess of fluid needs (Dobson p. 223).

From an equity perspective Federal orders gave processors within a market equal access to milk at uniform prices, and farmers equal access to prices as well (Babb p. 178). They altered the distribution of economic power, giving farmers more countervailing power with respect to handlers and processors. Blakley says the buyer side of milk markets is oligopsonistic, and that Federal orders help restrict the exercise of this power. "Removal of Federal orders would result in an income transfer from producers to the processing firms equivalent to monopsony profit that could then be obtained" (p. 298). The classified pricing does make grade B producers as well as processors relatively worse off, because the class I differentials tend to depress the manufacturing milk market (Buxton 1979 p. 783).

Some states have implemented their own Marketing Orders to organize dairy production and marketing, with slightly different provisions. Retail prices are fixed in some states, incl

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including Maine, Pennsylvania, North Dakota, and Montana (Manchester 1983 p. 174). Federal orders cover about 78 percent of Grade A milk, state orders regulate 18 percent, while only 4 percent of Grade A milk is covered by neither (Cook p. 23).

3. Federal Price Supports

A policy complement to Federal milk orders is the Federal Price Support Program. Created by the Agricultural Act of 1949, it required the Secretary of Agriculture to support dairy prices at between 75 and 90 percent of parity to assure supply, reflect changes in the costs of production, and support dairy farm income. The Secretary's discretionary power to set the price was removed by the 1985 Food Security Act, which implemented automatic triggers based on government stocks. Prices are supported through government purchases of nonfat dry milk, butter, and cheese, which provides a price floor for all dairy production.

The program provides an entitlement to dairy farmers of stable prices. What demand consumers will not provide to keep prices above the minimum level is expressed by the Federal government and paid by taxpayers. At times government purchases have been large: between 1980 and 1983 the Federal government purchased 10 percent of all milk marketings, at a cost of $2 billion annually (Marion 1986 p. 121).

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This is helpful for dairy farmers, not only because it supports their income, but also because the relative price stability it provides reduces the risks of investment. This is important in dairy production because of the immobility of many of the assets, as well as the long time it takes to receive payoffs because of production lags.

Dairy price supports have benefits for consumers as well, because the price and income stability encourages a higher level of production at any price (Christ p. 280). Consumer prices are stabilized, though in the short run they may be higher than they would be without the program. By providing a stable environment for investment and productivity change, consumer prices may be lower in the long run because of the program, if some cost savings are passed on to consumers (like the Treadmill). Similarly, stability helps avoid shortages and higher prices.

The Secretary's decision about appropriate level of support under the pre-1985 program was political, "in the final analysis," even though a great number of economic variables were considered in the deliberations (Christ p. 280). The current triggers (price drops $.50 per cwt. if government holdings are projected to exceed 5 billion pounds milk equivalent, or rises $.50 if holdings are projected to be less than 2.5 billion pounds) were politically set as well. Political power can be used to influence the level of government usage (through food aid or school lunch programs), affect

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affecting the level of holdings and thus support price. The large cost to the Federal Treasury in recent years has renewed interest in and concern about the program. Major changes may be forthcoming if Treasury costs increase significantly or if the current level of expenditures becomes politically unsupportable.

4. Definition of Actors and Product

A most controversial definition in the dairy sector involves dairy cooperatives and their limited antitrust exemption under the Capper-Volstead Act. The act gives farmers the right to form cooperatives, a right denied under the Sherman Act, as long as the cooperatives do not unduly enhance prices or restrain trade. This obviously has power ramifications because it changes the incidence of transactions costs. Organized farmers are in better bargaining positions relative to processors and handlers than individual farmers, in part because collectively they have lower information, policing, and contractual costs.

The issue, however, is not whether cooperatives were given power through market rules, but unavoidably of whose interests the market rules should favor. The act was intended to give farmers countervailing power to processors (Babb p. 170), in an effort to more evenly balance their respective bargaining positions. As the U.S. Supreme Court said about the act, "the general philosophy... was simply that individual

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farmers should be given, through agricultural cooperatives acting as entities, the same unified competitive advantage- and responsibility- available to businessmen acting through corporations as entities" (MD & VA Milk Producers Assn v. U.S., in Jesse 1982 p. 432). Removing the exemption would not eliminate bargaining power from dairy markets, but simply transfer the power advantage to other actors.

Equally important for the distribution of benefits but less frequently noted are rules influencing the organization of processors, wholesalers, and retailers. These include the right for individual investors to collectively pool resources into legally distinct entities (corporations), and merger and antitrust policies. The ability to form corporations has allowed firms to become larger than otherwise possible, able to take advantage of economies of scale in production, handling, and marketing. The processed cheese and cheese food market for supermarket distribution, for example, is largely controlled by two firms (Manchester 1983 p. 197), while retail food chains are rapidly gaining market power by virtue of their ability to vertically integrate (Cook p. 87), concentrations impossible without rules allowing people to combine resources.

The definition of products is especially important for the dairy industry because of the felt public need for health and safety regulations on milk, and because consumers are not easily able to differentiate between different qualities of milk without formal grades. The rules specify what kinds of product can be bought or sold, based on health standards (such as pasteurization, bottling requirements, sanitary standards, and presence of "foreign" substances like medications) or other concerns (such as the USDA's refusal to consider permitting sale of reconstituted fluid milk because of concern about its effects on the industry [Babb p. 184-5]). The standards help consumers know the quality or potential safety instead of making them guess, in the absence of standards, which bottles of milk are contaminated and which are safe.

As mentioned previously, Federal orders define milk as a "flow" commodity, with farm gate pricing based on the average use of all milk instead of the exact use of milk from cow "X". The type of pooling is an element in this definition, because it clarifies whether the "product" is the average of the value of the entire market's sales (with market-pooling) or of the specific handler's (with handler-pooling). This rule creates certain incentives and opportunities, just as a different rule would create other incentives.

Another product receiving definition are market services provided by cooperatives which benefit all producers (such as maintaining the fluid reserve). Some market orders allow cooperatives to charge nonmembers for these services, while other market orders do not, forcing the cooperative members to bear all these costs themselves.

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5. Ownership of Knowledge

Ownership of the knowledge embedded in biogenetically created bGH creates other distributive effects. Potential excludability, whether through legal rights (patents) or the complexities involved,[7] influences the level and types of competition between users. The relatively small number of bGH manufacturers, as well as the laws defining them as actors, mean that manufacturers are able to set their own prices instead of merely accepting them from others. "Undue price enhancement" does not apply to them under the status quo rules, while it does to organizations of farmers.

Acquisition costs for the knowledge (access, as well as initial creation through research and development) are similarly affected by the rules of order which influence who pays for creating the knowledge and who owns or controls the results of that research. Ownership and control affect who has access and how such access is achieved, as well as who has a claim on the resulting benefits.

Marion (1988) has expressed concern that much biogenetic research is funded by the public even though private firms or the individual researchers become the owners of some of the specific knowledge created (and thus have claim on the value

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[7]i.e. if the knowledge is effectively restricted because a person needs "X" years of postgraduate study to understand it enough to be useable.

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of the knowledge). Besides the related concern about who decides what will be researched with public funds, the major entitlement question is who should have a claim on the benefits from expenditure of tax funds.[8] Entitlements to new knowledge from public research could be assigned to the public, freely available for anyone's use; owned by the public, sold to the highest bidders and excluded from others use; assigned to the researcher actually doing the work, or some other possibility. The choice obviously affects incentives for researchers and for others to contribute to the research effort, as well as the distribution of benefits.

6. De facto Entitlements

The dual nature of rights means that the appropriateness of market rules depends upon whose interests are considered sovereign, and that recognition of one person's claim means denial of another person's claim. Masson and Eisenstat note that "regulation (market orders and the Capper-Volstead Act) reduced the costs of predation" (1980 p. 274) for cooperatives, but did not mention that these "regulations" intentionally increased the costs of predation for others, specifically reducing the relative power of handlers and processors to prey on dairy farmers. The question is who will be allowed to prey on whom. Simple judgments that "Federal

[8]Another related concern is the incidence of taxation, and thus who specifically paid for the research.

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orders are bad" carry an implicit value judgment about whose interests should receive precedence in the rules of market operation.

The effective entitlements in the dairy industry are the result of whose interests these rules favor, an interdependent process between the types of situational interdependence present and the rules. Increasing the power of farmers reduces that of processors, and vice versa. The combination of the rules outlined above produces a set of effective opportunities and claims that influence the distribution of income. These will be briefly reviewed for each actor.

a. Dairy Farmers

Dairy farmers are entitled to a price floor provided by the Federal government. This floor does not directly change with the quantity produced (within the large target range of government holdings) but is politically set. The support price reduces income and price instability, and makes long run investments more attractive, as well as supplementing farm income.[9] This can be seen as a subsidy, compensation, or an expression of a preference for orderly marketing, depending upon perspective,[10] though the program has been more of a price

[9]This latter judgment is speculative, as part of the "what would have happened" concern.

[10]This will be discussed more fully shortly.

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stabilizer than price enhancer for most of 1950-78 (Gruebele p. 159).

Pooling arrangements similarly reduce uncertainty about markets, and reduce the pressure for each farmer to fight for the most lucrative uses of their own milk. The "product" sold by farmers becomes a flow, freeing farmers from handling difficulties during peak seasonal production fluctuations. Returns to farmers are equitable, in the sense that all producers in a region receive the same price for milk. It does reduce the potential income of the savvy farmers who would be able to exploit superior management skill or geographic location if pooling did not exist. It also ties total quantity produced in a region to the price received: the greater the quantity and thus higher percentage of milk going to manufacturing, the lower the pool price. Classified pricing transfers the possible opportunities for price discrimination from processors and/or retailers to farmers. Farm level incentives for increasing production are based on the average value of output, not on the marginal value of production.

The Capper-Volstead Act helps farmers by allowing them to collectively organize, a boon because it increases their bargaining power and thus influences their terms of trade, reduces transactions costs, and because collective action allows farmers to vertically integrate into milk handling and processing. The latter means farmers can receive the value of pr

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of providing some marketing services as well as the value of the milk.[11]

b. Handlers & Processors

The price support program aids handlers and processors as well, because it means they are always able to sell milk products without regard for the level of consumer demand. During times of seasonal supply fluctuations they are able to dispose of excesses beyond their fluid needs, reducing their uncertainties about the quantity of milk procured from farmers. It also helps provide price stability to the market, reducing the risks of investment.

Price classification and pooling also obviously affects handlers and processors. The classification reduces their ability to exploit the different price elasticities of demand, because it explicitly gives the benefits to farmers. Pooling provides a measure of equity, because it means all handlers and processors have access to milk at the same prices. The "product" they purchase is homogeneous according to source, reducing supply uncertainties and raising the relative importance of transportation costs. Pooling reduces the ability of handlers and processors to price bargain (inside the orders), as does the countervailing power allowed farmers

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[11]Manchester (1983) argues that over order payments (payment above the minimum classified price) to cooperative members are returns to these services normally provided by processors and handlers, not monopoly profits.

through the Capper-Volstead Act. Processors' and handlers' strength comes, in part, from their own ability to collectively organize as investors under the legal auspices of corporations.

c. Consumers

Consumers are guaranteed adequate supplies of fluid milk and relatively stable prices by the rules. The fluid reserve acts as a buffer for unexpected fluctuations in demand and supply, and retail prices are a function of the administratively set class I differential and M-W prices, not directly of such local fluctuations.

The price supports may increase retail prices in the short run, but the stability they provide can reduce prices in the long run by encouraging productivity increasing investments. Retail prices for dairy products have increased slower than the average of all foods since 1935 (Manchester 1983 p. 214), a direct benefit to consumers.

The health regulations have helped protect consumers from potentially dangerous milk, important because most consumers are not able to determine the presence of harmful bacteria or other health threat on their own. At the same time, however, they limit the choice sets of consumers who are willing to take the risks in exchange for lower prices or who believe that the standards are too restrictive and harmful (such as people who believe unpasteurized milk is more healthy).

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d. Taxpayers

The cost of boosting dairy prices up to target levels is borne by taxpayers. The level of costs depends on the quantity of milk produced, consumer demand, and the target price level. The latter is a political decision, driven in part by the need to keep government costs within acceptable bounds (Christ p. 282). Federal orders cost taxpayers relatively little.

One of the original stated aims of the supports was to supplement dairy farm income, but the program now can be perceived in several ways. Supports can be viewed as a subsidy to dairy farmers as originally intended, or equally legitimately as compensation for adopting productivity increasing innovations which reduced farmer returns as well as retail prices. The perspective makes a difference in the normative evaluation of the programs, as well as for the political sustainment of the programs. Dairy farm entitlements are politically secure enough at present that instead of reducing dairy surpluses and government costs through reduction or termination of the programs, the government bought out the claims of some dairy farmers in exchange for agreements to cease production.

Even though taxpayers pay the costs of the supports and receive few direct benefits as taxpayers, they do receive benefits in their respective roles as consumers, dairy farmers, handlers, or processors.

B. Brief History of BGH

BGH is a naturally occurring hormone regulating milk output in dairy cows, produced in the pituitary gland. Increasing the level of bGH in a cow increases milk production. Biogenetic engineering allowed this fact to be exploited because it made artificial cultivation of the hormone on a commercial scale possible through biogenetically altered bacteria. Quantities of the hormone are now feasibly available at relatively low cost, making its use a potential alternative method for dairy production. If use becomes common, the distribution of income from dairy production will likely change, and the potentially large increases in milk production could stimulate a redefinition of entitlements.

Whether bGH will become an alternative for dairy farmers, as well as its relative attractiveness, is still unclear because many choices about it have yet to be made. The major constraint on adoption at this point is that the FDA has not yet determined if bGH is a threat to the environment or safety of cows, and consequently has not given approval for use. FDA approval for human consumption, both in milk and meat, has already been granted. BGH is naturally present in milk, and is rendered inert by human digestion, so the latter approval came relatively quickly.

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While FDA safety tests (on the cows) were being conducted in California, milk from these cows was sold through ordinary market channels. Consumers learned that they were purchasing milk with synthesized bGH (hereafter referred to as "bGH milk") and were outraged. Retail outlets and processors demanded "formal written assurances from raw milk suppliers" that they would not be given bGH tainted milk (Browne p. 15). The strength of this consumer response suggests that consumer acceptance of bGH, even if approved by the FDA, is not guaranteed.

Bovine response to bGH is rapid, with increases in milk production following three or four days after first application and continuing as long as daily application continues. BGH is given during the second and third trimesters of lactation, increasing daily production from 15-40 percent depending upon the study (Boynton p. 148). These two trimesters, however, only account for 62 percent of annual production because yields typically decrease as lactation continues (Marion 1988 p. 82), so the higher daily yield increase of 40 percent translates into a possible 25.6 percent annual increase in production (Yonkers p. 2). A more likely daily yield increase is 24 percent, translating into a 15 percent annual increase in yield per cow (Marion 1988). These are results gained in laboratories, so actual increases on farms will likely be much less.

The effect is reported to be proportionate on all cows without regard to their "natural" productivity. Low yielding cows are as likely to respond as high yielding cows. The amount of bGH needed for the production response is very small: a third of an ounce (weight) is enough to treat one cow for an entire year (Novakovic p. 9). Feed requirements do increase simultaneously with yields, meaning that the increased production is gained at costs beyond application of the hormone. These have been estimated to be a 6.2 percent to 7.2 percent feed cost increase for a 10 percent increase in milk production[12] (Marion 1988 p. 83).

Four firms are gearing up for production of bGH, including Monsanto, Upjohn, American Cynamid, and Elanco Products. Prices have not been announced, but the companies report that dosages will likely cost between $.25 and $.75 a cow per day for daily injections. Time release applications, which would avoid daily injections of the hormone, are likely but the daily costs will be higher.

C. Distributive Decisions

The distributive consequences of bGH will depend crucially upon the choices determining actors' relative opportunities as well as the mere production and consumption decisions within this larger framework. Adoption rates, price

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response, and demand response are vital, but are functions of the order and states of knowledge, not self existing in and of themselves. The influential decisions can be categorized by the Entitlement and Productivity framework into four sets: choices of order, choices of knowledge, choices of method, and choices of production, consumption, and effort.

1. Choices of Order

The choices of order are crucial for the distributive impact of bGH, and involve several primary decisions. The first is whether bGH is defined as a product available for sale or distribution. Secondly, the definition of milk produced with bGH must be clarified: is it an identifiably different product than non-bGH milk or the same? Thirdly, changes (if any) in dairy farmer entitlements under Federal price supports will affect incentives, production, consumption, and effort, and the distribution of benefits. Fourthly, the ownership of bGH knowledge affects incentives for research and who can claim benefits.

a. BGH as a Product

The current commercial unavailability of bGH is because it has not yet received complete FDA approval, and is therefore not legally a product which can be used in milk production. The FDA has decided that milk and meat containing traces of bGH are not threats to human health, but have yet to r

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to rule about bGH's safety for the animals and for the environment. Without this ultimate approval bGH will not be a legal alternative for farmers.

A refusal to endorse bGH for dairy production would forfeit the sunk costs of researchers and potential bGH manufacturers who have invested resources with the expectation of bGH production and sales. These have been substantial for some firms. But similarly, while saving these investments endorsement would ultimately reduce the asset values of others, including processors with large dairy manufacturing capacity who would be harmed if the government felt it had to reduce the volume of purchases,[13] farmers unable to adopt bGH for whatever reason, and others hurt by the changes in production methods. Endorsement (or lack thereof) unavoidably affects the value of assets. Any choice between who will suffer these losses is an equity, rather than an efficiency concern.

b. Endorsement of Milk

A related issue with major distributive consequences but receiving less attention is the definition of the product produced with bGH. Specifically, whether milk produced with bGH is identified as a product separate from milk produced without the hormone. Physically bGH produced milk is no

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[13]Because of increased program costs stemming from supply response.

different than "naturally" produced milk, but if consumer response in California is indicative, they are perceived as different products by consumers. Even if response by consumers in other regions is less dramatic, it is highly likely that the demand for bGH and non-bGH milk is different.

The definition of bGH milk is an issue similar to that with grades and standards. Consumers individually are not able to determine whether a unit of milk was produced with bGH because of the high detection costs involved, just as they are not able to determine presence of harmful pathogens. Who bears these information costs is important; if consumers' rights to know are affirmed, farmers and processors will pay the information costs of grades distinguishing bGH and non-bGH milk; if farmers' and processors' rights to avoid bearing others' information costs are affirmed, consumers will have the option of paying the information costs or of taking the risks about product origin.

If bGH milk must be identified as such at point of sale, its retail price will likely need to be lower than non-bGH milk to overcome its relative unattractiveness to some consumers. Incentives for adoption would be much less, and the distributive consequences less dramatic on the dairy sector and less beneficial to bGH manufacturers. It may not even be feasible if bGH milk prices are lower. Conversely, treating both types of milk as identical products would create stronger incentives for producer adoption, greater bGH sales by

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by manufacturers, and possible changes in consumer demand for milk.[14]

Deciding between these alternative product definitions (and distributive consequences) is a value judgment, unanswerable by economic theory. Economists usually take consumer preferences as given, as does the concept of "efficiency." Arguments that consumer identification of two separate milk products, even though physically identical, is irrational and that economic efficiency suggests they not be separately identified, arise from value judgments outside the framework of economic analysis. Scitovsky says it is meaningless to apply the criterion of economic efficiency to measures aimed at influencing consumers' market behaviors

[14]There is an inherent enforcement difficulty if two separate products are distinguished, because the two kinds of milk are virtually identical. The policing costs would be high. Non-bGH milk would receive a higher price than bGH milk. Insuring that bGH produced milk is not sold as non-bGH to get the "premium" would be difficult. The incentives for cheating would increase as the price differential between the two increased. If enforcement is not perceived as effective by consumers, trust in non-bGH milk would likely fall, with a consequent reduction in demand for dairy products. The long run consumer response is difficult to predict, because it may be affected by advertizing, education, news reporting, or other influences on perceptions and product differentiation.

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(1971 p. 72), precisely what this action does.[15] Economics cannot tell whether they should be separated: if anything, the implicit values in traditional economics would suggest they be identified as separate products because consumers perceive them as decidedly different.

c. Changes in Price Supports

Current dairy farmer entitlements are relatively separated from the quantities produced and production costs, with the exception of the $.50 ratchet up or down under the 1985 Food Security Act and the increase of Class II utilization when production increases are greater than fluid demand increases (causing blend price to fall). Cost-saving benefits from bGH would accrue to producers in so far as these entitlements do not change. All adopters benefit until the support prices are changed, not just the early ones as in the treadmill scenario.

It is widely recognized that these entitlements will be threatened by bGH (by the large potential rise in program costs needed to remove increased production) and by the

[15]If the concern is to meet consumers' physiological needs without regard for their preferences, Thurow suggests considering the cheapest medically balanced diet. "By combining soybeans, lard, orange juice, and beef liver (edible, cheap, nutritious, but hardly enjoyable foods), a medically balanced diet can be created that costs less than $80 per person per year (1959 dollars). It would be a better diet, medically speaking, than most of us now eat. But are we really willing to compel people to eat it?" (1973 p. 66)

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current Federal concern with the level of government expenditures. Changes in these entitlements are political decisions, so are hard to predict, with the distribution of benefits from bGH in the balance. Reductions in support price would likely transfer benefits to consumers through lower prices, to the extent that handlers, processors, and retailers were unable to capture them. Reductions, however, will reduce the incentives for use of bGH and lower the quantity of bGH sold by manufacturers.

Class I differentials may be altered as well, if regional political pressures are able to exert enough influence to shift relative prices among regions for dairy (as happened with the 1985 bill which favored southeastern producers). This could easily arise if dairy producers in the affected regions are perceived sympathetically as unduly threatened by others' adoption of bGH. Regional changes could similarly arise through changes in state orders, imposition of or changes in state price supports, or other state-level redefinitions of markets.

2. Choices of Knowledge

The prior state of knowledge in dairy production which determines the alternative production methods known (but not necessarily available or feasible) was altered by biotechnology firms seeking to create a product to sell to dairy farmers, rather than by farmers or dairy processors atte

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attempting to solve a perceived problem. The incentive for research and development of bGH was the possibility of selling the innovation to the sector, rather than the researchers using the innovation themselves. It was created because manufacturers wanted a claim on income from dairy production, a claim hopefully obtained in exchange from farmers for increasing dairy income via bGH induced production increases. Incentives arose from the prospective legal demarcation of bGH as a saleable product and from the relative inability of farmers or others to use the knowledge of bGH and biotechnology to produce their own supplies, allowing research costs to be recovered.

Creation and control of artificially produced bGH allowed the biotechnology firms to name the product as well, one aspect of defining public perception and acceptance of it. The recent change from "bGH" to "bST" signals such an effort at changing attitudes because the word "somatotropin" at present has less negative rhetorical associations than "hormone." Groups opposed to the use of bGH prefer to use its old name for the opposite reason (Browne 1988). The ability to name is an important element in influencing public perception of a good, and the label for bGH is embroiled in that effort.

The future value of bGH depends upon the state of knowledge about health effects of use. At present there are no known deleterious health effects of artificial bGH on

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humans, but there is always the possibility of such later discoveries. One reason some consumers in California were cautious about bGH milk is from fear that these effects will later be found (or disclosed) after the milk has already been used (perhaps used over a long period). It is also possible that deleterious effects are already known, but because of rights to that knowledge and information costs it has not become widely known (as happened with the results of some cigarette company research during the late 1950's and early 1960's). The uncertainty and risk affect consumer perceptions and acceptance.

3. Choices of Method

Producers' choices between available methods of production are important, because productive potential depends upon the methods chosen (the specific levels of production chosen are subsumed in choices of production, consumption, and effort). The rate at which producers adopt bGH affects the distribution of income, both through the speed of adoption and in who adopts (and who does not). The latter includes geographical and farm size differences.

Adoption decisions are individual and thus difficult to predict, and are clearly a function of the relative opportunities available to each actor by the rules of order. These include whether bGH is an available option for an individual (legally defined as an option, plus whether they have the res

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the resources needed for adoption) and the incentives for use (the relative attractiveness of bGH, including perceptions of risk). Choices of order and of production, consumption, and effort influence both of these, and thus affect adoption. Actual prediction requires a deductive model of behavior.

Some have expressed doubt about whether bGH will be an attractive option for farmers. Sawyer believes that the aesthetics of using bGH will be a deterrent to adoption[16] (1986 p. 156), while Marion wonders whether farmers will be "economically rational," much less whether they can perceive a response to bGH. He notes that a feed additive called Isoplus that increases milk yield by 10 percent has not caught on with farmers despite its low cost, in large part because it is only used on part of the herd at a time, and so its effects are not so visible (1988 p. 81). BGH's use during the last two trimesters of lactation may similarly make the yield increases less apparent. At the same time, most dairy farms presently do not attempt to maximize yields wholly on economic criteria. It is not a priori certain that dairy farmers will adopt bGH just because it increases yield or potential returns.

[16]"The thought of working around 500 dairy cows who are stuck each day with a 14 ga. needle and injected with a substance as thick as Karo Syrup does not appeal to me."

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4. Choices of Production/Consumption/Effort

Choices of production, consumption, and effort are those decisions within the range of opportunities available under the order of the market. The major choices of principle actors with bGH will be examined, attempting to show how the decisions interrelate to influence the distributive effects of change.

a. BGH Manufacturers

The pricing strategy of bGH manufacturers is vital, not only for influencing their level of returns, but also for the relative attractiveness of the hormone for dairy farmers. The level of adoption of bGH depends upon how attractive the hormone is, in part a function of its price. A low price will increase the number of potential users, while a high price will only be potentially profitable for above average producing herds (Tauer 188 p. 30).

Manufacturers will likely set prices to attempt to maximize profits, without regard for the distributive effects of price level on who can adopt. Finding that profit maximizing price will be difficult for them because of the uncertainty about farmer response, as well as uncertainty about policy responses.

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b. Production Level by Farmers

The quantity of milk produced by dairy farmers depends upon the level of farm gate prices and the costs of production (the latter a function, in part, of the production method chosen, the response of bGH, the price of bGH, and the increased feed costs with bGH). Farm prices are affected by consumer demand, Class I differentials, and the level of price supports. High prices act as an incentive to increase production through expansion, while lower prices reduce incentives and may force some producers to quit production. The relative inflexibility of dairy production means quantity responses are slow, and in the short run that price reductions only affect quantity when returns no long cover variable costs. Reductions in Federal price supports would reduce the incentives for using bGH on lower yielding herds, and in the long run could force some dairy producers to quit production.

The costs of producing milk would vary between the bGH method and the non-bGH method, with the relative attractiveness depending upon the cost of bGH, yield response, and increased feed requirements, as well as whether farmers can perceive the differences in yield.[17] A given milk price level will have different distributive impacts on adopters and

[17]The perception of yield increases may depend upon the farmer's management skill or scale of operation. Top producing farms, for example, often keep records on each cow's production, using the information to balance rations. The perception of the increase potential may thus not be scale neutral.

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nonadopters depending upon these. If the cost savings are sufficient and prices fall enough, nonadopters could find prices below their own costs, and be forced to either change methods (if that is an available option) or quit production. Kalter suggests this will happen if bGH becomes widely used and prices are allowed to adjust (p.90).

c. Purchases by Consumers

The quantity of milk purchased by consumers depends upon whether bGH milk is identified as a separate product or if it is defined in the market as identical to non-bGH milk. The distributive effect of distinguishing between the two is unclear, because it depends upon their relative demand and substitutability, as well as price. If California consumers' responses are an indication, non-bGH milk will continue to have strong demand, though it may be more elastic because bGH would be a substitute.

If bGH milk is not treated as a separate product, consumer trust in the safety of dairy products may fall, decreasing demand. Decreased fluid use would lower blend prices at any given level of production, because the proportion of milk used for manufacturing would increase. If consumer demand for fluid fell more than for manufactured,[18]

[18]Elasticities are not helpful for predicting the likely changes because they attempt to measure variations of quantities demanded, not shifts of demand.

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blend prices will fall even more. These reductions would occur even without adjustment of support prices of Class I differentials.

d. Purchases by Government

The level of purchases by the Federal government depends upon the level of commercial removals, the quantity produced, and the support price. These are interdependent. The quantity produced by dairy farmers reflects, in part, the support price which places a price floor beneath production. Similarly, the level of government purchases affects the support price by the $.50 ratchet under the 1985 Food Security Act and by affecting the political consensus behind the program. Large purchases and treasury expense can destroy the consensus and lead to new policies or lower levels. One concern about bGH is that its production response will contribute to change in the program.

Finally, if consumer demand falls because of adoption of bGH, government purchases will increase for any given level of production. This also significantly lowers the support price level necessary for the government to either stop purchases or to only procure a given amount. This can be illustrated with supply and demand curves.

In Figure 5.1 the Federal support price is PS_0, which under the pre-bGH conditions (demand D_0 and supply S_0) leads to commercial removals of Q_0 and government purchases of

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Figure 5.1

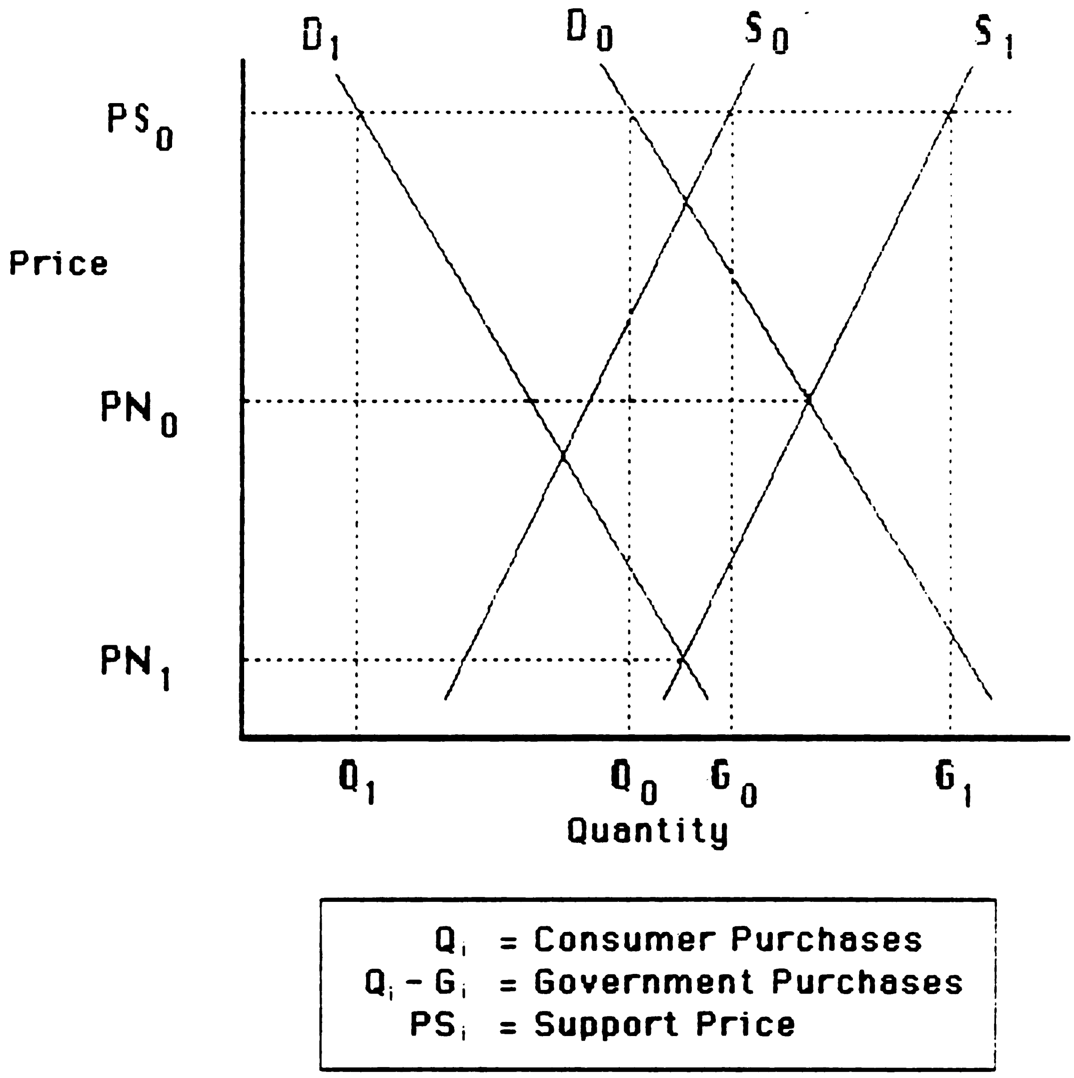

Figure 5.1 Consumer Effect on Government Purchases

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$(G_0 - Q_0)$. Adoption of bGH shifts supply to S_1, increasing government purchases to $(G_1 - Q_0)$ at the same support price. Commercial removals do not change. If consumer demand for dairy products falls because of bGH, to D_1, government purchases increase further to $(G_1 - Q_1)$. Notice that if the government decides to reduce purchases to any given level, the support price must fall more to achieve that level when consumer demand has decreased. This is most obvious when the possibility of zero government purchases is considered, where PN_0 and PN_1 would be required. These results mean that if consumer demand falls because bGH milk is not sold as a separate product, either taxpayers will pay more or producers will be hurt more, depending upon where the support price is set.

D. Implications of the Analysis

The analysis here has been oriented more towards the division of prospective benefits and costs than on predicting the level of those results of change. An entitlement and productivity approach, focused on the institutional context which helps structure opportunities and incentives, is useful for highlighting some of the influential distributive decisions, not on predicting the exact levels of what will occur. These relevant choices involved in change (and made by actors) clearly involve the context of market behavior as well as those behaviors themselves.

Two types of implications can be drawn from this case study. The first involves the distributive implications for bGH suggested by the framework. What will happen obviously depends upon more than production and consumption decisions. The second type of implication relates to researchers' choices of appropriate framework for analysis. Each will be discussed in turn.

1. Implications for Distribution

The distribution of benefits and costs from bGH depend in part upon the resolution of the distributive decisions discussed earlier. These decisions[19] determine whose interests will be expressed in the market as well as the effective weights on those interests. This can be referred to as the endowments, but the term can too easily disguise or minimize the complexity of the origin of individuals' relative opportunities. They arise from the interaction of the underlying types of conflict present (situational interdependence), the rules adjudicating the conflict, and the state of knowledge and thus available methods of production.

Entitlements are the claims effectively recognized by this process. Other claims (interests) which conflict with

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[19]These are the major decisions involved with interdependence. There are a myriad number of other decisions which also influence distribution.

those effectively recognized go unsatisfied. The choice questions discussed earlier decide between the conflicting claims, determining the appropriation of benefits as well as who can influence what actually occurs. These demarcate efficiency and productivity by weighting which interests count[20] and which do not.

The interdependences (and conflicting claims) about bGH requiring resolution are manyfold (and not mutually exclusive), but primarily involve:

1) Rights to knowledge (Joint Impact Good). Who owns the knowledge, and who can be excluded from using it (who must buy it from whom?). The public helped fund the research creating biogenetically created bGH, as did private firms, but who can directly claim the benefits of the knowledge? Public ownership (available free to anyone, or sold to the highest bidders) versus private ownership.

2) Information costs about the Product. Consumer interest in knowing what is in a product (pathogens and hormone) versus processors' and farmers' interests in avoiding the costs of informing consumers (avoiding the costs of special labels, handling, and other costs of conforming to grade standards). Few individual consumers can afford to pay the costs of testing if they are responsible for the information costs.

[20]"Efficiency" has no meaning without a performance standard (or interest) whose achievement is being accomplished. Recognition or acceptance of one interest implies denial of other conflicting interests.

3) Ownership of the Incompatible-Use goods. The claims to ownership of cows, units of milk produced from a given cow, and a unit of bGH are important, but are easily taken for granted because they are status quo, and thus the conflict is less obvious. The definition of these units is most controversial, determining whether the unit of milk owned by the producing farmer is identified as a generic gallon, or is identified as bGH milk or "natural" milk (depending upon use of the hormone). The identification likely makes a difference for the exchange value of the goods.

4) Exchange rights to bGH milk. Farmers' interests in producing milk as they choose versus consumers' interests in avoiding specific substances about which they individually might not be able to detect or know the related health risks (as with mechanically deboned meat or sale of unpasteurized milk).

5) "Right to Farm" versus right to be exposed to the vagaries and competitive pressures of the market. Is the farming lifestyle of such moral (or other) importance to the country that family farms should be protected even though other forms of farm organization may be more cost effective producers?

   The interests of family farmers who would not survive without protection versus those who pay the costs of protection (consumers, other farmers who would reap higher incomes without the production surpluses, and taxpayers). At present there is an element of protection in dairy production, expressed through price supports. Market wide adoption of bGH has the possibility of increasing the costs of this to politically untenable levels, leading to a change in the recognition of interests.

6) Fluctuations in supply of milk.[21] Consumers' interests in stable prices and sufficient production to satisfy the quantity demanded, and processors', handlers', and farmers' interests in stable prices, versus consumers' interests in paying marginal value of production, grade B milk producers' interest in selling to manufacturers without competition from grade A fluid reserves, grade A producers' interest in selling without paying for the excess capacity, and processors' and handlers' interests.

If adoption of bGH occurs, compensation to those bearing the costs of adoption (displaced farmers, consumers concerned about bGH,[22] and others) depends upon the political power of those affected. BGH has the potential to change the value of dairy farm entitlements. Some farmers may be put out of business because of change in price supports, politically orchestrated because of bGH induced increases in production (and thus program costs). The change would not necessarily be perceived as a violation of farmers' entitlements because the entitlements (and value) arise directly from political power.[23] Any compensation will depend upon the political power of farmers and others sympathetic; it may be necessary to "buy out" some farmers' claims to get enough political consensus to change the program, as occurred with the dairy buyout in

[21]The interests conflicting here are those under the Federal Market Orders.

[22]If bGH is not identified as a separate product (or different grade).

[23]In contrast to labor entitlements to tomato harvests, which was effectively taken by growers' change to a new method of production.

the mid 1980's. Judicial attempts to force compensation will likely not work, nor will economic threat.

2. Implications for Analysis

The Entitlement and Productivity Framework offers a perspective different from Neoclassical Theory because it focuses more explicitly on the effective entitlements to the benefits from technical change. The types of distributive choices involved with bGH are more apparent than with Neoclassical Theory, useful for policy makers because it helps illustrate the inherent conflicts of interests as well as offers a systematic way to relate the decisions. Neoclassical approaches, including Induced Innovation Theory, taking the status quo entitlements as exogenous and focusing primarily upon the role of relative prices, effectively assume away a major part of the distributive puzzle they attempt to study. They are not incorrect at their own level of analysis (relative prices are important), but that level is restrictive and limiting.

Analysis of bGH with Neoclassical methods has proved problematic for many, in large part because the analysts realize that the distributive effects depend upon more than production and consumption, but are unable to investigate beyond this realization. Many studies simply select three or four plausible institutional responses to bGH and see how supply and demand react, because the methodologies are not designed to consider institutional issues.

Tauer recognizes that the "interesting questions (about bGH) are more than price, quantity, revenue and utility" (1988 p. 27) but suggests that this implies a need to build "a total system of the economic relationships involved,... by mathematical programming or econometric estimation or some combination," a modeling task which has stymied researchers so far (p. 27). Such a behavioral model, however, likely will not be able to capture the nuances of the market context because the types of choices involved (whose interests) can not be represented mathematically. Browne suggests a more appropriate unit of analysis would be on the political economy of the new innovation (p.9), a concern reflected in this case study.

The role of assumptions is important. Some of the major issues about bGH are the conflicts which must be adjudicated before relative prices have meaning. Analysis focused primarily upon the likely production and consumption decisions assumes away many of the major issues about bGH, and makes the choices of order appear inevitable or less important, missing some of the complexity involved and the decisions about whose interests count and whose do not. Relative prices are important explanations for individuals' actions, but only within and reflecting the context of prior choices between conflicting interests.

The assumptions in the Entitlement and Productivity Framework are equally influential. The focus on choices of order makes it more difficult to predict production and consumption decisions because the focus increases the number of possible weights and decisions. The focus on the institutional context does highlight the distributive decisions involved with bGH, offering more insight into the process of productivity change and income distribution.

Chapter 6

Pickling Cucumber Case Study

Another good illustration of the role of choice in determining the distribution of benefits and losses from productivity change, as well as an interesting case study in its own right, is the development, adoption, rejection, and prospective resurrection of mechanical pickling cucumber harvesters. The cucumber harvester is primarily an ex post case, though further change is imminent. The ex post perspective offers contrast to the ex ante of the bGH case, and allows the descriptive potential of the Entitlement and Productivity framework to be explored.

The case involves two separate mechanical harvesters: the first adopted during the 1960's, then slowly abandoned during the 1970's in a return to hand harvesting as market conditions changed. The second harvester, only recently developed and not currently under manufacture, vastly improves upon the earlier machine and has the potential of again being substituted for hand labor as well as altering other aspects of the subsector. The method of cucumber production varies regionally as well, offering another dimension of comparison. Furthermore, it is a relatively unexplored case with only one previous study attempting to deal with the gains and losses of change.[1]

A major difficulty involved with the case study was the dearth of information on pickling cucumbers. As a minor crop, it has received much less attention from data collectors, making precise information hard to find. Available data series do not match up as well as desired. The statistical reporting service, under the impact of a major budget cut, ended acreage, production and season average grading station price reporting after 1981. The Michigan Employment Security Commission collected employment information on migrant pickle harvesters during the 1960's, but quit after 1973. The total value of retail pickle sales are only available for the mid-eighties. Retail price series merely consist of relish prices, which are not necessarily reflective of the prices of other pickle products. Michigan farm information lumps fresh and processed cucumber growers together, even though they are not similar. Much of the other information, such as specifics

[1]Cooke (1985) used Economic Surplus to estimate the benefits and losses from the first harvester, but did not deal with the decline of usage nor with the second harvester. His estimates of Consumer Surplus and Producer Surplus are also suspect, because they were based on retail prices of pickle relish instead of sliced pickles. Mechanical harvesting produces an over abundance of damaged fruits and bloaters, which Cooke says are "useful only as relish" (p. 27). This price series thus provides the most favorable Consumers' and Producers' surplus: the price of gherkins would not have been so favorably influenced, especially since processors had to search out new producers to obtain enough product due to the failings of the harvester. The Consumer Surplus and Producer Surplus estimates are likely too high.

about contracts, is proprietary and has been inaccessible to me.

Available information itself is slightly suspect. Much of the information in government documents is self reported by actors, so may not reflect true conditions. Some experts suggest that these figures may be misguided by strategic misinformation (Henry p. 61). Production records indicate total tonnage, not a breakdown by grades, even though grade percentages have great bearing on the value of production. The standard operating procedures in the pickle industry also vary widely, making it difficult to generalize about contracting, marketing strategies, responses to mechanization, and other relevant issues. Wages have chronically been difficult to estimate, because workers in pickles are traditionally paid by splitting total acre returns with growers.[2] Estimating the exact change in remuneration is difficult, because much of this remuneration is nonwage (such as short term loans, weekends off, guarantees of complete work schedules, finding workers complementary employment, better housing conditions, etc).

The paucity of published information was supplemented by interviews with growers, processors, harvester manufacturers, labor, and industry experts familiar with the mechanization,

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[2]The difficulty was one impetus for studies in the late 1950's on actual returns to Bracero workers (the Worker Yield Return Formula, or WYRF) and, in part, for the ongoing controversy with the Department of Labor.

as well as referral to extension bulletins and research papers arising during the period under study.

A. Entitlements in the Pickle Subsector

The entitlements in the pickle subsector arise from the interaction of the situational interdependences (conflicts) inherently involved in the nature of the goods and the rules which adjudicate the interdependence. The situational interdependence present will be discussed before reviewing the extant rules and de facto entitlements in pickle production.

1. Situational Interdependence Involved

One of the major influences within the pickling cucumber subsector has been the seasonality of cucumber production, which creates seasonal fluctuations in the need for planting, cultivating, and other aspects of raising the raw cucumbers, harvesting, and processing. This is exacerbated by the extreme perishability of the green stock (unprocessed cucumbers).

Cucumbers in the field are rapidly maturing fruits, capable of a 40 percent weight gain in 24 hours at maturity. Timely harvest is essential or quality and therefore the value of the crop will quickly change. Secondly, harvested cucumbers need to be processed quickly. They have a fresh life up to 36 hours, "after which they are unfit for processing" (Henry p. 38). Coordination is essential between planting, harvest, and processing, or excessive waste will occur.

Specific ownership of cucumbers, labor, processing plants, and of each machine are important because these are incompatible-use goods. The value of ownership is affected by the rules of exchange, which define what goods can be exchanged (as well as the method of doing so). These affect distribution by determining who can make claims, as well as influencing the value of those claims.

Ownership is also important because these goods are imperative for cucumber production under the state of knowledge, meaning that effective access to labor, machines, and processing capacity affect who has the effective option of producing cucumbers. Transactions costs, combined with ownership, further structure opportunities by influencing the costs of acquiring these goods, and thus of access.

Transactions costs are also important because of the risks from the product perishability. There are lots of relatively immobile investments which must be made by actors, with the attractiveness of investment dependent upon uncertainty and perceptions of risk. Once made, these leave actors dependent upon others. Timeliness of exchange is important.

The knowledge in mechanical harvesters is a joint-impact good, able to be used by others with negligible marginal cost.

Rights to this knowledge, including the right (and cost) to exclude others, is important for distribution.

2. De Facto Entitlements

a. Processors

Pickle processing is distributed across the country, in part because high transportation costs make it advantageous for processors to be close to the ultimate consumers. Over 35 percent of total U.S. processing is done in Michigan (Henry p. 18), with other processing done in states such as Delaware, Texas, North Carolina, and Mississippi. Product shipment is expensive: raw product requires refrigerated shipping for more than short distances, while finished product is heavy because of the brine and jars. Processing is dominated by several large national firms (one is reputed to control 60 percent of the market), but includes many smaller regional firms.

The seasonal fluctuations in cucumber production are problematic for processors because much of the processing capacity is immobile, unuseable for other commodities. Processors are forced to balance having enough capacity to handle peak supply fluctuations (without spoilage) with the opportunity cost of having this capacity idle much of the year. The fluctuations are mitigated in several ways: interregional shipments of green stock to more fully utilize processing plant capacities are common despite the high costs of shipping; production contracts with growers reduce risks of unused capacity, can help spread deliveries of green stock more evenly during the production season, help processors plan production schedules, and reduce transactions costs during the harvest time; brining green stock for later processing allows capacity to be used during more of the year (instead of just during the cucumber harvest season); and varying the level of advertising and merchandising of brand product (which affects consumer demand) helps supply meet demand without major price fluctuations.

The bulk of pickling cucumbers are produced under forward contract with processors, with comparatively little sold in open market transactions.[3] Processors contract with growers pre-season, stipulating prices for different grades,[4] and usually dictating planting dates, seed variety, and acreage. Usually the same growers are used each year: adjustments in supply are made through varying each grower's acreage instead of increasing or decreasing the number of growers.

Pickle processors estimate the quantity of cucumbers they need, based on expected sales, promotions, and stock needs, calculate the acres required for this quantity, and then apportion these among their growers. They base the prices

[3]Brokers, who sell through open market transactions, help coordinate supply and demand, but account for very little of the volume moved and for discovery of price. For this reason their omission from analysis is not too disruptive.

[4]The grades are based on cucumber diameter. Smaller cucumbers are worth more than larger grades.

offered on the value of alternative crops, according to several industry experts. Growers can merely accept the prices offered or refuse to produce, not negotiate new prices. Because processors establish the terms of contracts, they are able to create or change grower (and harvest worker) incentives, most typically for the emphasis on grades picked, but also occasionally to reduce harvest risk to growers by purchasing fruits in the field (which are then picked by the processor's employees).

There are four general types of pickle products. Fresh pack are pickled directly in their jars, brined are temporarily stored in brining tanks before being packaged for sale, relish, and refrigerated pickles, which are similar to fresh pack except the pickles are not subjected to as high a temperature during packaging, making them highly perishable (they must be sold within six weeks). A cucumber can be processed into any of these products, but grades and needs typically influence processing allocation decisions between them. Oversized or damaged fruits are useful only for relish. Brining allows processing capacity to be more fully used throughout the year, because brined cucumbers can be processed after the seasonal influx of green stock.

Investments in processing plants are relatively immobile, with few alternative uses outside of pickle processing. Processor choices are constrained within the need to either remain pickle processors and continue use of existing facilities, or lose these investments. With product differentiation important in retail markets, trade names and reputations are similar assets which would be partially or wholly lost if pickle production was foregone. If growers refuse to produce cucumbers or are unable to harvest planted crops (within feasible transportation range) processors would have no choice but to shut down and absorb these losses.

Processor reputations are important, especially with growers and customers. Cucumbers are easily damaged internally, but this is not evident until after processing has begun, when it is too late for processors to trace the damaged fruit to the responsible grower. Grower loyalty, through fairness, is important to maintain to insure that growers took care with the product. Similarly, brands are differentiated, but customer loyalty could be changed if the processor developed a bad reputation either for quality of product or for integrity of the organization.

Pickle products are marketed by processors through two general channels. About two thirds of total volume is sold through retail outlets, with brand label product accounting for 75 percent of these sales and private label consisting of the rest (Progressive Grocer October 1976 p. 48-49).[5] The remaining one third goes to the food service industry (Henry p. 15).

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[5]According to the same source, this brand label share is low compared to many other dry grocery items.

Even though both brand and private label products are sold through retail outlets, their handling and incidence of associated responsibilities differs. Brands originate with the processors, who coordinate their moves down to the retail level. Retailers provide shelf space, while processors provide advertising, promotion, and distribution. Processors carry storage of product until it is required by retailers, shipping in response to the frequent but small orders. Retail prices are usually based upon relatively rigid markups over wholesale. Processors can influence the quantity sold by altering direct to consumer advertising and promotion, or changing price and promotion activity to food retailers (Hamm p. 427). Product differentiation by consumers is important, but brand loyalty by consumers is relatively less for pickles than other products (Progressive Grocer. July 1981 p. 85).

Private label products are intended to be low cost alternatives to brand products. Distributors contract with processors, putting their own private label on the product. The processor is thus unknown to consumers because it is the distributer's label which gives the product identity. Distributer level private label buyers are able to purchase from any processor willing to follow the specifications and offer a good price. Sales by private label processors are thus close to pure competition.

Retailers, who purchase private label products from the distributors, are responsible for advertising, promotion, merchandising, and pricing. Retail prices are typically set lower than brand prices, with a fairly steady price spread between the two. Margins on private label product are usually set higher by retailers than margins than on comparable brand products. This equilibrates retail profits on the two (Hamm). Average margins (both brand and private label) for pickles are higher than on many other dry groceries (Progressive Grocer July 1984-88).

The food service industry purchases product from processors based on quality specifications, with the identity of the processor usually lost by the time product reaches consumers. Processor sales to the food service industry are thus also relatively competitive, with price and ability to satisfy the specifications important.

Consumer demand for pickles is relatively inelastic: there are not many close substitutes or complements for pickles, nor is a high percentage of consumer income spent on pickles. Price or income changes do not have great effects on the quantity of pickles demanded.

Once processed most pickle products are relatively shelf stable. There are still year to year supply fluctuations that when combined with the relative inelasticity of demand would create major price fluctuations, but these are reduced by processors' ability to influence demand through advertising and merchandising (Hamm). During years of low supply advertising and merchandising is reduced, while during years of large supply these are increased. Retail prices are made relatively more stable than they would be without the shifts in demand.

b. Growers

Average acreage planted by growers in the early 1960's varied across states, but growers did have some commonalities. Most growers were diversified, with cucumbers as one of several crops produced. The equipment necessary for cucumber production was not specific to cucumbers, allowing growers to shift to alternative crops without sustaining the capital losses associated with immobile assets.

The crop diversification was one method used by growers to mitigate the seasonality of cucumber production. The other crops had complementary (non-competing) time requirements, allowing growers to keep busy throughout the summer season. Cucumbers typically were the last crops planted and among the first harvested.[6]

The seasonality of production and potential risks of immobile investments were further alleviated through production contracts with processors. Transaction costs, potentially problematic to growers because of the perishability of green stock, and hence need to sell it quickly, were also reduced by the contracts. Almost all

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[6]The maturation time for cucumbers is less than many other crops.

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pickling cucumbers were produced under forward contract with processors, with prices for different grades, variety and acreage specified before planting occurred. Growers tended to contract with the same processor each year. Cucumbers have not provided windfalls to growers, but are a popular crop because prices remain relatively stable.

All growers originally relied on hand harvesting. Hand harvesting traditionally occurs every other day throughout a field's six week harvest period, allowing selection of fruits at their optimal size. Availability of harvest labor during this time is crucial, or the crop will be lost. Most growers in North Carolina had under 10 acres (Henry), and relied upon their family's labor for this labor. Michigan and Ohio growers had much larger acreage, and thus were forced to rely upon hired labor, typically migrants. Sixty seven percent of cucumber harvest labor in Michigan during the late 1950's were Mexican nationals, with the proportion increasing to 80 percent by the early 1960's (Mason p. 3), temporarily brought into the U.S. under the Bracero Program expressly to harvest crops.

The fluctuations in the need for hired harvest labor, and risk that workers would not be available (or willing) to harvest the crop was initially alleviated by having the processors supply the workers. The processors were better able to keep workers busy until they were needed by a specific grower (busy so the workers would stay in the area). When

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processors shifted responsibility to growers (in the 1960's) the growers tended to use the same workers each year, reducing the transaction costs of finding labor and offering some continuity to employment. The Bracero Program provided security of access to workers at the same time it also lowered the transaction costs of finding and hiring workers.

Hand harvesters were traditionally paid by growers with a 50-50 split of the value of product from the harvested field. This allowed growers to share the risk of production value with harvesters, insuring that the most growers could lose with production was their planting, cultivation, and opportunity costs. It also provided incentives to harvesters to find the smaller, more valuable fruits and maximize the value of the harvest.

c. Workers

Hired workers also had to deal with the fluctuations in the demand for their labor. They handled this by developing a chain of different short term agriculture jobs in various crops, which in sum provided steady employment throughout the spring and summer season. Cucumbers were only one job within this chain, providing a small portion of workers' total yearly employment and income. The completeness of their work schedule (few of no idle weeks) had great bearing for their total income.

This migration also helped growers of different crops handle the severe peak demands for labor. It allowed an individual grower to have access to many workers for a brief period without having to pay the entire cost of bringing (or keeping) those workers in the area, as well as provided enough incentive for workers to come to a region. Michigan was at the end of one chain but provided enough variety of crops and months of work to make it worth workers' trek that far north.

The Bracero Program provided foreign workers who effectively competed for domestic harvest jobs, even though the program ostensibly would only allow foreign workers into the U.S. when sufficient domestic workers were not available. It was commonly believed that domestic workers would not want to harvest cucumbers because of the uncomfortable nature of the job (lots of stooping and prickly fruits).

Labor (effort) is an incompatible-use good, so ownership is important for the distribution of benefits from it. Market rules, however, control what kinds of labor can be exchanged (adult labor and childrens' labor, for example) as well as on what terms[7] that labor can be exchanged. These affect who can sell their labor, the minimum remuneration required by law, and the transaction costs of employment.

[7]Minimum wage? Worker compensation required? Social Security? Health or safety requirements on worker or employer?

B. History of the Mechanical Harvesters

1. First Harvester (Pinch-Roller Type)

The creation and adoption of the mechanical sugar beet harvester during the late 1940's and 1950's exerted new forces on these interrelationships. Sugar beets had been a crop complementary to pickling cucumbers for harvest labor, and this development threatened the supply of labor in Michigan. With a reduced seasonal work schedule, migrants had reduced incentives for making the long trek to Michigan. Actors realized that the potential mechanization of other complementary crops further threatened the migrant labor supply, and thus the ability to harvest pickling cucumbers. No option to hand harvesting existed for pickling cucumbers, spelling doom for processors who would be unable to shift to alternative crops if the subsector collapsed.

Processors tried to explore and develop alternatives. H.J. Heinz Co. began searching during the 1940's and 1950's, looking at mechanical devices developed by innovative growers (Stout 1963; 1969). These did not provide the desired relief, nor did growers' scattered efforts offer hope for great success in the future because of the lack of concentrated resources and expertise. Mechanical alternatives to hand harvest were felt to be a matter of survival for the industry, requiring greater attention.

Processors united on this effort, through the National Pickle Packers' Association (NPPA)[8] appealing for assistance from others. In the spring of 1956 NPPA and Heinz held a meeting with the Agricultural Engineering Department at Michigan State University to solicit this assistance (Cooke p. 16). MSU researchers adopted the project, soon deciding that a single pick technology (one pass with the machine destroys the plant) was the only feasible approach, despite the traditional six week harvest period for cucumber fields. Salaries and support were provided by the University, with additional funding provided by a cooperative research agreement drawn between the NPPA, Scott-Viner Company,[9] and MSU, providing $16,000 over three years (Cooke p. 18). Scott-Viner helped in this effort because of an offered five year patent protection for Scott-Viner to exploit any discoveries.

The research focused on a pinch-roller technology, which uprooted the plants and used pinch rollers to separate the fruit from the vine. Development had reached a stage by August, 1963, that MSU and FMC formally settled on terms and began field testing two prototypes on Heinz acreage in 1964 (Cooke p. 21).

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[8]Which later became Pickle Packers' International (PPI).

[9]Which merged with the Food Machinery Corporation, later known as FMC, in 1962.

In December, 1964, Congress allowed the Bracero Program, which had been providing 80 percent of Michigan's pickling cucumber harvest labor, to expire. Processors and growers in Michigan were concerned that domestic workers would be unwilling to fill this supply shortfall and would be less productive. They responded by reducing Michigan's pickling cucumber acreage from 24,800 acres in 1964 to 17,300 acres in 1965, a fall of 30 percent. Production per worker per year fell from 312 bushels in 1964 to 193 bushels in 1965 (MESC). Other states were much less dependent upon Bracero labor and were not as severely affected. Acreage nationwide only fell a little more than 9 percent.[10]

Harvest costs for Michigan acreage increased, with pickle wages rising 57 percent from 1964 to 1965 (MESC 1966). Nonwage provisions also increased. Wage and nonwage provisions in other crops rose because of the competition for workers (Mason p. iii).

Processors looked to the FMC harvester as an alternative, but it was an imperfect substitute for hand harvest.[11] Firstly, it was an immobile investment for growers, with no alternative use for growers outside pickle production. Purchase made shifting to other crops more costly because of

[10]From 110,900 acres to 100,410 acres. Source: Agricultural Statistics.

[11]According to one processor representative, machines are always a second choice to hand harvest.

its immobile nature, increasing the risk to growers. Because contracts were renewed yearly, there was no guarantee that a grower would be able to use their machines into the future, further increasing the risk. Lease of harvesters, instead of purchase, was relatively unattractive because of the extreme perishability of fruits in the field, but done in some areas: a delay of even one day because the machine was not available could reduce the value of harvest by 5-10 percent, and even as much as 20 percent. The machines did reduce labor needs, down from 150 man hours an acre to only 5 man hours an acre (Brown).

Secondly, because it allowed only one harvest per field, yields were much lower than with multiple hand picking.[12] Yields were also poorly representative of the smaller sized grades because the machines could not pick them, troublesome because the smaller grades were more valuable. This meant that one ton of machine harvested cucumbers was worth less than one ton of hand harvested. The quality of product also differed from hand, with more dirt, stems, and culls (oversized and damaged) fruits.

More importantly, the scale requirements for production were different with machine harvest. Hand harvest could be scaled to the acreage by merely adjusting the number of

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[12]Initially yields were only 80-90 bu/acre, or around 2 tons/acre (Cargill 1975), compared to over 5 tons/acre using hand harvest (Agricultural Statistics, 1962-3).

workers hired, but the machines did not offer such incremental possibilities. Acreage instead had to be scaled to the machine. Researchers suggested that the optimal utilization of the machine was 10 acres/day, or 75 to 200 acres/machine/season (Cargill p. 3), to spread the fixed cost across as many acres as possible. Smaller producers unable to fulfill these requirements were forced to either quit production, increase their acreage, depend upon leased equipment, or continue reliance on hand labor.

Growers were reluctant to adopt the new harvester, necessitating incentives from the processors. Some producers created two price systems, paying different prices depending upon how the fruits were harvested. Several companies had to assure growers $125 an acre as an "enticement" for growers fearful of the inefficiencies of mechanical harvesting. Others offered growers purchasing harvesters a guaranteed contracted acreage per machine, typically 80 acres. This was meant to reduce the risk of purchase associated with scale requirements and asset immobility. Some processors purchased machines and used them on growers' acreage, reselling them to growers after several years when growers were familiar with their operation.

FMC produced five harvesters in 1965, while other manufacturers quickly began research into their own models or increased their efforts to perfect their earlier designs. Thirty-four more FMC harvesters were produced in 1966 (Stout), the same year Wilde Manufacturing introduced their own design. The Wilde machine was similar in harvest method to the FMC, but was tractor mounted instead of being self propelled, had reinforced parts, and at between $15,900 and $16,900 (including the tractor) was almost half the price of the FMC machine.

The Wilde machine quickly found favor with growers and processors, increasing sales to 40 machines in 1967 (Stout) while FMC was unable to sell any.[13] Several other companies explored production of the machines, including Blackwelder Manufacturing Co. (producer of the mechanical tomato harvester), Porter-Way Harvester Manufacturing Co., Aeroglide Corporation, Solbern Sales Corporation, and Hart-Carter Company[14] (Stout p. 298-301). Only Cuke, Inc. and Wilde survived manufacturing into the late 1970's.[15] Neither had recovery rates as effective as hand harvesting.

With the poor yields, it was evident that the new state of knowledge was not entirely satisfactory. Research continued at land grant universities, sponsored by the schools and the USDA (both ultimately by taxpayers) to develop

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[13]To add insult, FMC was forced to repossess six machines sold earlier, although two of these were later resold as used (Cooke p. 24).

[14]The rights to the Hart-Carter machine were purchased in 1973, with production continuing under the Cuke, Inc. name.

[15]Current (1988) prices are $22,500 for the Cuke, Inc. machine, and $39,500 for the Wilde machine (tractor not included).

complements to mechanical harvest which would increase the effectiveness of this method. New cucumber varieties were developed which were bushy instead of vining, lifting the fruits off the ground for easier pick up. Increases in the number of ripe fruit present in the field at harvest would increase yield, so research into planting densities, cultivation, and pollination was conducted. Planting densities were increased to 60-80,000 plants/acre (machine), up from the 20,000 plants/acre typical of hand harvest, increasing interplant competition and the need for fertilizer and irrigation. The higher density prevented mechanical cultivation, and because cucumbers are highly sensitive to traditional herbicides new chemicals needed to be developed. Pollination had relied upon bees, but overhead irrigation (predominant in Michigan) tended to drive bees away. The timing of harvest also had to be more accurately planned, in an effort to find the optimal harvest window for each field. The rapid growth of cucumbers meant that harvest value changed quickly. Sampling techniques and decision matrices (relating estimated field values and growth curves) were developed to help growers make harvest decisions.

Research produced new states of knowledge, and as these were adopted by growers yields with machines increased from 2 tons/acre to an average 4 tons/acre in 1974 (Cargill 1975). This was complementary change, not major change in the machine technology, and had the simultaneous effect of increasing the productivity of hand harvest.

Adoption between pickling cucumber producing states was uneven, in large part because of the difference in size of operations and access to labor. North Carolina growers, with their smaller acreage and use of family labor, did not embrace the new method of harvest. North Carolina's share of U.S. production remained fairly steady throughout this time.

Michigan adopted the harvester, though many growers quit and were replaced by corn farmers more familiar and comfortable with machine based production. Those who quit did so for assorted reasons: the problems of finding sufficient labor, the increasing social stigma of hiring migrants, and a sincere wish to avoid a heavily machine dependent crop, as well as the inabilities to marshall the resources (financial and acreage) needed to adopt mechanical harvesting. The number of pickling cucumber farms in Michigan dropped from a high estimate of 2011 farms in 1964 to 839 in 1974, while average acreage increased from 12 acres to 28.5 acres.[16]

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[16]Source: Michigan Census of Agriculture. The number of farms is an overly high estimate, in that the Census does not separate fresh market cucumber farms from processing cucumbers. Pickling cucumbers, however, are consistently 92-95% of this total acreage reported, according to Agricultural Statistics. The Census also does not sort out extremely small producers (under one acre, for example, and typically fresh market farms), resulting in an under representation of the average size of pickling cucumber farms.

Peak domestic employment in Michigan increased at the end of the Bracero Program, rising to 18,533 in 1967 (compared to 16,309 total peak workers in 1964, a figure including 12,843 Braceros) but then plummeting to 8,860 in 1971 (MESC). During this time period hiring practices changed as well. Formerly processors had recruited and housed harvest workers, but increasing social stigmas about hiring migrants as well as stirrings of unionization spurred processors to abandon this function.[17] Growers assumed the responsibility for recruiting and housing labor, but many in Michigan did not have the requisite housing.

Labor availability had been increasing in the late 1960's because of illegal immigration, according to several growers. There was such a concern over an enormous surplus of workers in Michigan in 1971 that agencies actively tried to discourage interstate migration (MESC). The lack of adequate housing and fixed investments in machines made it difficult for Michigan growers to take advantage of this labor supply.

Processors had been unable to acquire small cucumbers because of the machines' inadequacies, so they shifted their contracts out of Michigan to where hand labor was available. Ohio had remained hand harvest, and had the housing necessary for more workers to increase production. Ohio's contribution

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[17]Processors predicted that union organization would be more difficult if the workers were not centralized at processor camps, but were housed on individual growers' farms.

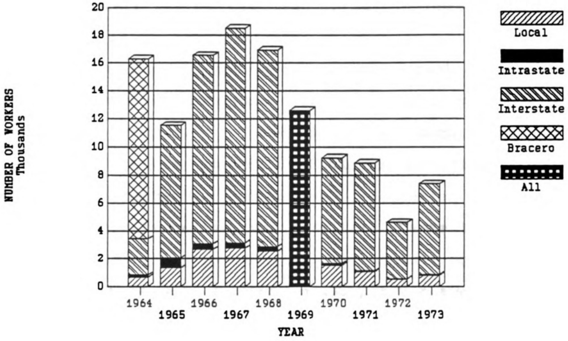

Figure 6.1 Peak Employment in Michigan Pickle Harvest

to U.S. total production increased from 3 percent in 1964 to 10 percent by 1980, while Michigan's dropped from 27 percent to 17 percent.[18] Cooke suggests that Ohio directly captured Michigan's share. Ohio was close enough to Michigan to allow the established plants in Michigan to economically process Ohio's output, even considering transportation costs. Processing stayed in Michigan because the plants could not move.

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[18]Agricultural Statistics, 1966-1981.

Retail prices had been decreasing with the influx of Bracero workers during the 1950's, but climbed after the termination of the program (Mason p. 167).

Use of mechanical harvesting reached a peak in Michigan in 1973, when it accounted for 91 percent of Michigan production (Motes).[19] Despite this high adoption, dissatisfaction was rampant. Unhappiness with the cash returns from mechanical harvesting, realization that labor (and thus an alternative) was available (VanEe 1984 p. 2), mechanical inability to collect the smaller grades, and excessive damage soon shifted industry favor away from the pinch roller harvesters. Many mechanical growers quit. Statistics on all years are not available (Haffar 1983), but by 1979 use of the mechanical harvesters had dropped to 70 percent, and by 1984 to 40 percent of Michigan output.

2. Second Harvester (Thresher-Type)

With this dissatisfaction and decline in use of the pinch roller harvesters, processors began searching for other alternatives. A threefold approach intended to improve the performance of the harvesters was begun in 1978, involving

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[19]Figures on adoption may be somewhat misleading. At least in the early years (up to 1972) "a 20 acre field may (have been) harvested by machine but only for the final pick, probably having been hand picked two to four times before that. Hence, labor picked 20 acres and the machine picked 20 acres, but labor no doubt picked two to three times as many pickles as the machine" (MESC 1972 p. 22).

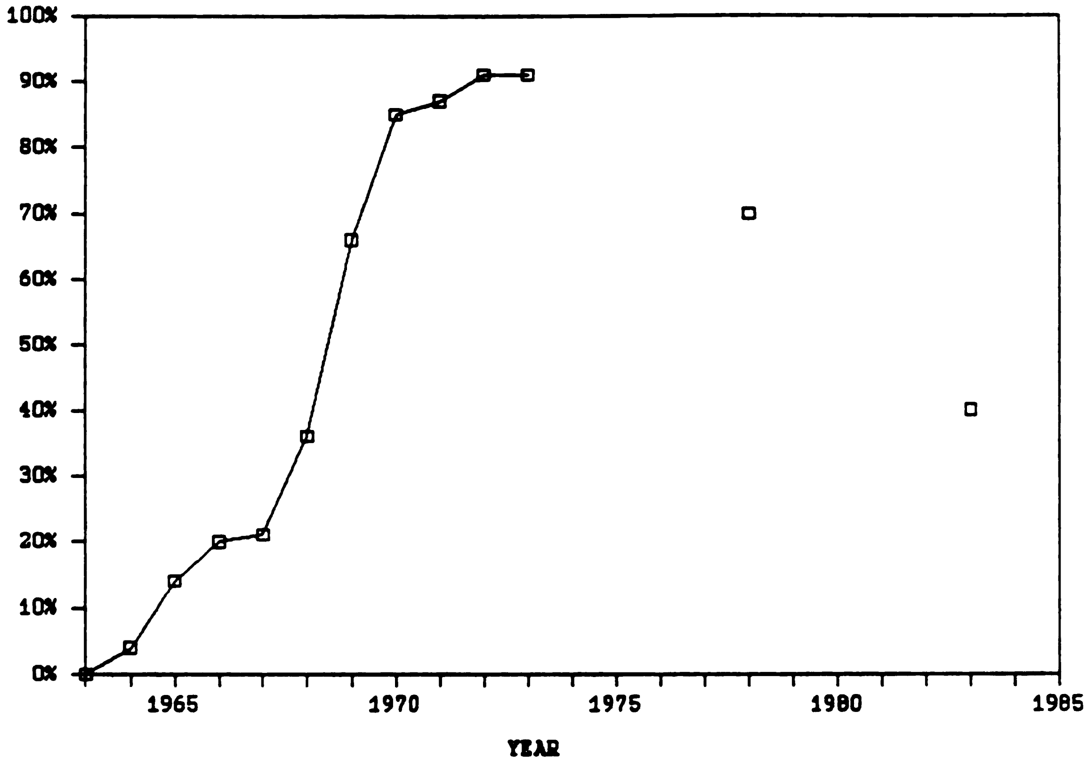

Figure 6.2 Percent of MI Cucumber Crop Mechanically Harvested

both industry representatives and MSU. Funded by PPI, it sought to develop gyneocious (100 percent female) hybrid cucumber varieties, create chemical fruit pollinators (both meant to increase the number of ripe fruits available at harvest), and physically improve the mechanical harvester's recovery of small cucumbers (VanEe 1981).

This research suggested that a thresher type harvester (similar to grain harvesters) had potential, but needed further development. A new 3 year research project was formed in 1981 specifically to concentrate on this task, funded by

Table 6.1 Percent Fruit Recovery with Mechanical Harvesters

Grade Prototype	Wilde	Cuke, Inc	New MSU
1	30%	23%	59%
2	60%	62%	76%
3 & larger	80%	90%	88%

Source: Wilde: Rotz 1982; Cuke, Inc.: Haffar 1984b, p. 183; MSU Prototype: VanEe 1984 p. 6

PPI, the USDA-ARS, and MSU. Vlasic supplied 50 percent of PPI's contribution. Prototypes were tested, eventually yielding a promising model which had a better recovery rate of smaller cucumbers, had a capacity of 500 bu/hour (12 tons/hour), plus $50-100 more fruit an acre than the earlier designs (VanEe).

A patent was applied for in 1983, and the rights to develop the production prototype given to Wilde Manufacturing in 1984. This production model was never built, however, because Wilde was forced into bankruptcy by another business deal.[20] The thresher type harvester is still not available for purchase.

Vlasic, meanwhile, soured on the PPI effort and withdrew their support from the collective processor effort. Vlasic

[20]Wilde Manufacturing has since been recreated.

instead turned to FMC, hiring them to develop Vlasic's own proprietary harvester. A prototype was due around 1985-6, but has not yet appeared.

During this time industry concern with the availability of labor again flared because of three separate events. The Immigration Reform and Control Act of 1986 introduced severe penalties on employers who hire undocumented workers and provided for citizenship to illegal aliens who had resided in the U.S. for a set period of time. Growers and processors were concerned that the Act would reduce the supply of agricultural laborers by reducing incentives for illegal immigration and allow pickle workers to seek more remunerative employment because of newly gained citizenship, as well as increase the cost of using undocumented workers by the imposition of stiff penalties. Record keeping complexities increased.

The Department of Labor has also been attempting to clarify the employment status of hand pickers of pickling cucumbers. At issue is whether laborers are independent contractors or employees of growers, affecting what kind of contracts are possible and what rights can be traded. The Department argues that laborers are employees, and hence subject to the provisions of the Fair Labor Standards Act of 1938 (FLSA) which includes minimum wages, child labor restrictions, and specific record keeping requirements.

Growers and migrants argue that workers are contractors, outside the purview of the FLSA.[21]

Several pickling cucumber growers have been taken to court by the Department for violations of the FLSA, with mixed results. In Michigan (Donovan v. Brandel, 1984) judgment was in favor of the grower, while in Ohio (Donovan v. Gillmor, 1982) and in Wisconsin (Brock v. Lauritzen, 1986) the Department won.[22] The Department's interpretation would eliminate the traditional 50-50 split for harvest labor, altering the incentive structure for harvest and shifting all harvest risk to growers,[23] prevent migrant workers from having their children assist them in the fields, and increase the record keeping costs associated with hiring labor.

The ultimate outcome and effect of this debate on pickling cucumber harvesting is unclear, but the industry has

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[21]The Farm Labor Organizing Committee, the labor union attempting to organize workers, sides with the Department of Labor.

[22]This issue involves the question of what rights adults can exchange (including the right to their childrens' labor). The FLSA proclaims that employees do not have the right to exchange their labor for less than an established minimum wage, even if done voluntarily, nor do employers have the right to accept labor for less than that minimum wage even if the employee freely accepts that exchange. As the court in Lauritzen said, "The FLSA is designed to defeat rather than implement contractual arrangements. If employees voluntarily contract to accept $2.00 per hour, the agreement is ineffectual" (p. 28).

[23]"With an hourly wage for labor, farmers will carry the added uncertainty of total costs of labor rising well above grower returns" (Henry p. 108).

been nervously watching. The major potential effect if the Department of Labor ultimately triumphs will be on harvest incentives for workers and the amount of record keeping growers will be required to handle. Incentive effects are not likely to be inconsequential, because the present contracting arrangement means that labor bears the policing costs needed for optimal harvest by unifying grower and worker interests. The paperwork (a transaction cost), however, is one of the consequences most dreaded by growers.

The third event concerning growers and processors involves the increasing organization of harvest workers in Michigan and Ohio. The Farm Labor Organizing Committee (FLOC), a labor union, is organizing tomato and pickle harvest workers in an effort to improve workers' conditions. Union contracts with growers as yet do not differ much in terms from non-union agreements, nor has the union achieved representative status for all the workers, but it has been able to exercise some muscle.[24]

The threefold concern about effects of the immigration bill, the legal status of labor contracting, and the unionization of workers has restimulated interest in the only available alternative method of harvest, the pinch roller harvester. Used machines, formerly stored unused, have been

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[24]Even though interest in the harvester has increased because of the union, the harvester has not been explicitly mentioned in labor negotiations, nor is it feared by FLOC as a substitute for their labor.

purchased and refurbished, and new orders for the older technology have recently increased.[25] Processors do not want to be left without alternatives if labor suddenly becomes unavailable. Many growers will likely respond by reducing acreage or shifting to other crops instead of mechanizing. This has been happening recently in Ohio as the labor situation there changes.

C. Distributive Consequences

The distributive consequences of the mechanical cucumber harvester can be roughly interpreted from three general perspectives; productivity, production costs, and the viewpoint of individual actors. Each will be discussed in turn, but with particular attention to the consequences on the various major groups of actors involved in the technical change.

The ensuing discussion of consequences will differ from the earlier distributive discussion about bGH, primarily because the technical change in cucumbers has already occurred. The consequences are relatively observable instead of speculative, as with the earlier case study.

Interpretation of the distributive consequences of the mechanical cucumber harvester depends, of course, upon the assumptions used during the analysis. This will be discussed

[25] From an average of only 2-3 a year in the late 1970's, to an average of 16-26 in the late 1980's.

more completely during the implications, but also during the analysis where appropriate.

1. Productivity

Productivity is ambiguous because it can be expressed in so many different terms: the basket of inputs varies greatly between hand and machine harvest (because of the great number of complementary inputs necessary for machine harvest), as does the output.[26] Using a measure such as Brown's, based entirely upon labor and land requirements (150 person hours/acre for hand versus 5 person hours/acre for machine), is misleading because the five hours of machine use produces much less (in value, grades, and total tons) than the 150 hours by hand, as well as uses a much different basket of inputs. His measure focuses on the time necessary to cover physical area, not on the time needed to recover a given value or quantity of production. If productivity was expressed in terms of physical output per acre, or in value of output per acre minus the value of inputs[27], the productivity of the mechanical harvester would be seen as much less impressive.

Productivity is a value relationship comparing factors to product, with the definition depending upon perspective

[26]Both quality and yield per acre are much lower with machine harvest, not to mention the price received per grade varies depending upon harvest method.

[27]Using Harsh and Patterson, Shapley, or Haffar and VanEe's estimates of costs and returns.

and entitlements. The concern of the processors and growers in this case study was with the supply of harvest labor, a worry that fomented the research into and adoption of mechanical harvesters. Brown's measure attempts to express this concern, but fails.

2. Production Costs

The economics of mechanical harvesting versus hand harvesting are unclear. Beyond the scale requirements of financing and acreage and the immobility risk to growers of owning a machine, it is not readily apparent which method is more cost effective because of their imperfect substitutability.

Estimates differ, depending upon the study. Cooke (1985) estimated savings in favor of machine harvesting of $.64/cwt at the farm, using Ohio enterprise budgets of 1976 and comparing a 175 acre mechanically harvested farm with a 15 acre hand harvested farm.[28] Harsh and Patterson (1969), in a cost of production budget, estimated total costs per bushel of $1.53 and $1.71 for hand and machine, respectively.[29] Shapley (1986) estimated a $42 per acre advantage[30] of hand harvesting over machine, creating a partial budget using

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[28] 1975 dollars

[29] 1969 dollars

[30] 1986 dollars

statistics from some Michigan growers. Haffar and VanEe (1984) estimated net returns of $200 per acre for hand harvest and $150 per acre for machine, also using a budget. The advantageous estimates of hand harvest are probably more accurate, given the reticence growers expressed towards mechanization, processors' need to offer incentives to stir adoption, and the eventual move away from the mechanical harvester during the 1970's when it was apparent labor was available.

Even though mechanical harvesters may have reduced per acre returns, they increased individual growers' total returns from cucumber production by allowing greater acreage than possible with hand harvesting. As the acres of hand operation increase on a farm, so does the problem of peak demands for labor. Transactions costs per worker for acquiring sufficient labor increase with larger acreage because size increases the need for supervision and local complementary employment. Mechanical harvesting eliminates the peak demand problem, allowing a grower to use much larger acreage.[31]

An equally important consideration is about risk: the value (or appeal) of the machines also depended upon one's risk preferences. The risks here were threefold. The first was related to the availability of labor sufficient to harvest

[31]Cargill recommended 75-200 acres a machine per year, while hand harvested acreage typically was less than 30 acres per farm.

cucumbers, while the second was the ability to shift easily out of cucumbers into alternative crops. These risks were part of what originally induced processors to push for development and adoption of the mechanical harvesters. The third involved the harvest risk of the value of product from a field. The one pass nature of the mechanical harvester increased the importance (and risk) of harvest timing decisions.

Availability of labor was primarily a threat to processors, though it had short run implications for growers. If labor appeared unavailable during recruitment season (in winter before production contracts are signed), growers could simply plant less cucumber acreage and more of something else. Growers had alternatives. Processors, in contrast, had few alternatives if labor was not available. They had big investments in distribution mechanisms, promotion, and shelf space, as well as cucumber specific processing capacity. These immobile investments would be forfeited by a change out of pickle production.

The second risk, of immobility of production assets, was assumed by growers simultaneously with their purchase of a harvesting machine. Hand harvesting growers were able to shift production without difficulty or large losses, while possession of the machines meant growers would have to pay fixed costs even if they were not used. The harvester reduced the ability of farmers to shift out of cucumbers, aligning growers' interests closer to processors'. Besides assuring that growers would not quit cucumber production lightly, the harvester favored processor interests in a more direct manner. By offering a method to insure that cucumbers could still be produced during times of labor shortage, the harvester reduced the risks borne by processors relating to their large existing immobile investments.

Harvest risk was increased by the mechanical harvester for two reasons. The great weight gain potential of cucumbers meant harvest timing with a one pass technology was crucial for harvest value. A one day difference in harvest could mean a decline in value of 5 to 10 percent, and sometimes 20 percent. Growers also bore the entire harvest risk with mechanical harvest, while they only bore half of it with hand harvest because of the traditional split with labor.

The value of the machines to growers depended in part upon the relative weighting they gave to these risks. If the former risk of labor uncertainty outweighed concern with immobility, growers could find it worthwhile to accept slightly smaller per acre returns with mechanical harvesters with the benefit of avoiding labor fluctuations and uncertainty. With acreage guarantees, smaller per acre returns could also be outweighed by the large increases in total acreage planted possible with the harvesters.

3. Actors

For the terms of the following analysis, the relevant groups of actors are six:[32] growers of cucumbers, pickle processors, domestic agricultural workers, machinery manufacturers, wholesalers/retailers, and food service buyers of pickles. Other actors (such as foreign agricultural workers, consumers, and growers of other crops) will be discussed in brief, but not to the extent of these prior actors. The benefits and costs are most dramatic for growers, processors, workers, and machinery manufacturers. Each will be discussed in two parts: level and direction of change; and division of benefits. The distributive impact on wholesalers, retailers, and food service buyers will be discussed more generally.

a. Processors

i. Level and Direction of Change

Pickle processors may have been the most individually powerful actors in the pickle sector, but they also had the most at risk to others' actions. The large immobile investments in cucumber processing capacity, product distribution mechanisms, promotions and shelf space were all specific to pickles; the cessation of pickle production would force processors to forego these large investments.

[32] Not including breakdown for geographical location.

Processors were dependent on growers for green stock, who themselves were dependent upon agricultural workers for the harvest of the cucumbers. If growers did not produce cucumbers, either favoring alternative crops or because workers indicated they would not harvest any cucumbers planted, processors would have few alternatives other than relying entirely upon costly refrigerated shipments of green stock from other regions. Losses to processors caused by any such grower or worker decisions were not compensable under the rules of order.

Growers could not exploit this dependence because the number of potential growers and lack of effective grower organization restricted their economic power. Conversely, for growers desiring to produce cucumbers the processors were economically powerful because the processors were able to withhold the purchase of cucumbers from anyone they desired. This economic power existed only as long as growers wanted to produce cucumbers, making it ineffective for processors to demand compensation.

Processors were similarly dependent upon wholesalers/ retailers and the food service industry. Brand label processors, providing their own distribution, advertising and promotion, and selling a differentiated product were less dependent than other processors, but still vitally needed shelf space from retailers. Processors oriented towards private label and food service production not only were dependent on others for this infrastructure, but also lacked the vestiges of economic power bestowed by differentiation. If their wholesale prices were not competitive with processors in other states, they would lose sales. Brand label processors tend to be larger, with more interregional links than private label processors, allowing them more of an opportunity to mitigate increased production expenses (at least in the short run) by spreading them across sales of product from all regions.

Processors played the major coordination roles in the pickle subsector, in large part because of these dependences. It was from this position that they realized the threat from the potential changes in labor supply. Decreases in worker availability would not overly harm growers, who could easily shift to comparable alternatives, but it would greatly impact processors and fixed investments. The potential changes were threats to processors, not to growers.

The effects would likely have regional differences as well. Changes in Bracero labor or migration patterns would have affected Michigan processors much more than other regions' processors because of Michigan's greater dependence on such labor. Brand label, private label and food service oriented processors in Michigan would all have lost without an alternative harvest method, but those in private label and food service would have been hurt much more because their product was homogeneous to that in other regions. Brand label processors had the option of using product differentiation to mitigate loss of regional competitiveness caused by increases in production costs.

Processors were the driving force for creation, development, and adoption of mechanical harvesters, in large part because they were the major actors with incentives for mechanization. They realized that another harvest method had to be created and promoted to keep growers in cucumbers and thus themselves from suffering immobile asset losses.

The mechanical harvester was developed, but provided less than the desired (by processors) alternative to migrant labor. Initial grower adoption had to be goaded with incentives and special prices, while use slowly dropped because of insufficient returns and an increasing availability of labor. Mechanical harvest was a second best alternative to hand harvest, so it was abandoned when sufficient labor became available (it became available, some allege, because of increasing illegal immigration).

It became clear that mechanical harvesters were not an attractive enough alternative to hand labor, and that the industry was thus still dependent on migrant labor. The potential changes in labor supply spurred further research, at the same time some labor interests attempted to minimize processor alternatives to hand harvest. One effort by FLOC to restrict processor alternatives involved dialogue with workers in Mexico, in the hopes of gaining their support and thus preventing processors from avoiding the union by using Mexican supplies.

Finding an alternative was important enough that Vlasic split from the industry research efforts to lessen its dependence on others. Ownership of the knowledge in a harvester would give Vlasic the ability to avoid pressure from other patent owners, machinery manufacturers, or other potential roadblocks to adoption. Simply owning the capacity for adoption reduces others economic threats in bargaining, even without production of the technology.

ii. Division of Benefits

Processors bore costs as well as benefits from the mechanical harvester. NPPA helped pay the costs of research and development to create the harvester, and processors paid some of the information costs necessary to help growers learn about the new option. The knowledge was not owned by the processors,[33] so they could not sell it or exclude others from its use. The incentives for adoption provided to growers were subsidies paid by the processors.

The cost of processing product changed as well. The pinch roller harvesters' ineffectiveness in collecting the smaller grades of cucumbers meant that processors had to look for unmechanized sources of small cucumber supply. Michigan,

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[33] Vlasic will have control of the knowledge in their new harvester.

with its large proportion of machine harvest, could not provide the needed product, so processors were forced to shift some contracting to nearby states, primarily Ohio. Transportation expenses increased because these locations were farther from processing plants. Transportation suppliers may have benefited from this.

Mechanical harvesters were also imperfect substitutes for hand in the quality of product. The percent of fruit with stems doubled with the machines (to 20 percent), as did the proportion of damaged large grade fruit (to 10 percent) (Marshall, Cargill & Levin p. 605). Cull fruits, formerly graded out in the field during hand harvesting, were now included in shipments to processing plants or grading stations. Without a prior hand pick of the field, the machine harvested cucumbers unavoidably were the "crown fruit" of each plant (the first to appear), the ugliest and most misshapen fruit a plant will produce.[34]

The once-over technology also exacerbated seasonal supply peaks at plants, increasing the need for coordination. Formerly the output from a field would be delivered to processors over a six week period, while with mechanical

[34]The behavior of a cucumber plant is to produce one fruit. If the crown fruit is not picked a plant will produce no more cucumbers because its goal is being fulfilled. The only way to get better looking fruit is to pick the crown fruit.

harvesters it would be delivered on one day.[35] Coordination between growers and processors became more important to insure availability of processing capacity, at the same time growers' need for timely harvest increased because of the rapid changes possible in field value with a one pass technology. Growers absorbed much of this risk because the value of a crop is determined when it is accepted at the grading station, not when it arrives at that station: if product backs up because the station is unable to accept the cucumbers quickly enough, growers absorb any loss in value due to product deterioration.[36]

The benefits of the harvester enjoyed by processors were primarily the protection of their immobile assets. The mechanical harvester allowed growers to continue production of cucumbers, keeping processor investments in processing capacity, promotion, and distribution from the loss which would have occurred without it. This was significant.

Processors have not captured per unit benefits from the mechanical harvester, as some might expect as a result of their market power. Since 1972 (when data becomes available) the value added by processors compared to the value of total

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[35]Albeit a smaller total amount than the six week total production with multiple pick, but a much larger daily delivery.

[36]Obviously, processors are not too happy about this situation either, because grower satisfaction is important for continued quality production.

Table 6.2 Value Added by Processors

Year	Value of Pack by Processors (Million $)	Value Added by Processors (Million $)	Value Added/ Value of Pack
1963	183.5	---	---
1967	238.7	---	---
1972	318.4	162.7	.51
1977	488.2	263.5	.54
1982	621.5	318.7	.51

Source: Preserved Fruits and Vegetables: Census of Manufacturers. Industry Series. 1963-1982. P. 20C-17.

pack has remained relatively stable at a little over 50 percent (see Table 6.2). If processors had been capturing rents, the value added would have been increasing relative to total pack value.

The harvester also benefited processors by reducing the economic power of labor. Worker threats of strike (labor withholding) are less intimidating when alternatives exist. This may prove more important in the coming years as cucumber workers unionize.

The increased capacity of the recently developed thresher type harvesters implies that adoption would draw growers and processors even closer together. Growers would require stronger guarantees of future production and acreage to adopt the more expensive machines, but would also become more interested in the continued survival of the industry. The larger acreage possible per grower would reduce the number of contracts needed, reducing transactions costs but simultaneously giving those growers more power relative to processors: the capital and acreage requirements for production would reduce the available pool of growers interested in obtaining contracts, reducing the ability of processors to play growers off against this pool and thus largely dictate terms.

b. Growers

i. Level and Direction of Change

Growers of pickling cucumbers were interdependent with processors because of the great coordination needed in production and handling, as well as the comparative lack of open market sales. Production contracts helped assuage price risk, but guarantees of sales (and thus effectively production) beyond the one year contracts offered by processors did not exist. Processors could refuse to renew contracts, but growers were similarly free to refuse as well.

Growers in North Carolina were less dependent upon the supply of off farm labor because their families performed the labor required on their comparatively small acreages. Growers in Michigan, Ohio, and other states with large acreages were reliant upon agricultural workers because no other methods of harvest existed. The traditional 50-50 split for labor remuneration allowed growers in these large acreage areas to share harvest risk and policing costs with hired workers, reducing the potential exposure of growers to uncertainty. These growers were also interdependent with growers of other crops, both of labor complementary crops in their regions (because the completeness of a work schedule across a variety to crops was one motivation for migrant laborers to come to an area) and for the political consensus needed to create and maintain programs to bring alien agricultural workers into the country to insure grower access to labor. The Bracero Program demonstrated an effective entitlement by growers through political power to such a supply of labor.

This entitlement was fragile, however. Labor supply in Michigan had been threatened earlier by the mechanization of sugar beet harvests. Beets had been a major labor complement to cucumbers, and their harvest mechanization threatened to leave a hole in the labor schedule and thus reduce incentives for workers to come to the area. Sugar beet growers also had exerted political pressure for alien worker programs before mechanical harvesting was widely adopted. The mechanization of cotton harvest further impacted the supply of labor for cucumbers by eliminating another group of growers from the coalition exercising political power to maintain the Bracero

Program. The reduction in political pressure for the Program spelled its eventual demise (de Janvry, LeVeen & Runsten p. 43).

Cucumber production did not require immobile investments by growers, and because ample alternatives existed for growers, the threats of labor supply uncertainty were less problematic than to processors. Growers could easily shift to alternative crops, reducing the incentive for growers to search for alternative harvest methods. Grower organizations were either non-existent or suffering from enough apathy that collective research was also not attractive.

The end of the Bracero program and the accompanying changes in the supply of labor affected growers differently, depending upon their location and dependence on migrant labor. Those in Michigan were uncertain about the prospective availability of workers, especially because Michigan was located at the end of migratory patterns and had been so reliant upon Bracero labor. Alternative crops existed plus assets were not specific to cucumbers, allowing a shift of production if needed. Many growers did this in 1965, when acreage in Michigan dropped severely. Growers in Ohio had been less dependent on the Bracero Program and had attractive labor complementing crops located in the area as further incentive for worker migration. Most North Carolina growers were unaffected.

When the mechanical harvest method became available, growers were not completely free to choose between it and hand harvest because their choices were made within the larger context of processor decisions. Machine harvest was only possible if the processor accommodated it with the proper handling systems, seed varieties, and new cultural practices required. Production contracts with processors had to be accommodative. The contracts more importantly, because they specified prices, provided the specific incentives faced by growers. The annual hiring arrangement with workers meant that either growers or workers could refuse to resume the employment relationship with impunity, allowing growers to adopt labor saving machines without paying compensation to workers.

Not all growers wanted to adopt the new harvesters. Many Michigan growers quit because they saw themselves as vegetable farmers, and did not like the idea of mechanical harvests. Other growers did not have contracts renewed because they "would not or could not change their management practices" to fit the new harvest method (Cooke 1985 p. 25). Data does not indicate the amount of grower turnover, only the total number of growers, which fell from 2011 in 1964 to 839 in 1974.[37] These were replaced by corn growers who were more comfortable with "machine farming." Those who had never grown cucumbers

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[37]See footnote 16 for caveat about grower numbers.

before "in general were the best adopters of the new technology... (because) they had nothing to unlearn about cucumber production" (Cooke 1985 p. 25). Those ending cucumber production primarily shifted to alternative crops. In Michigan, growers in the East adopted the mechanical cucumber harvesters in greater proportion than in the West, in part because the West was also home of labor complementary fruit crops (Henry p. 22) which would have had a harder time getting workers without pickle harvest work.[38]

ii. Division of Benefits

The division of benefits from mechanization depended most obviously on adoption. Grower adoption decisions were made in the context of the incentives and other opportunities offered by processors, including processor decisions about which growers were offered contracts and which were not. Some growers had no effective choice because of the options presented them by processors or the small scale of their operation.

Those growers who quit cucumber production, either because of processor action or conscious choice, generally did not suffer large damage because they had ample alternative

[38]Interestingly, Eastern Michigan was home to sugar beet production, which had been mechanized earlier. The cucumber harvester can be interpreted as a survival response of eastern growers faced with disruption of traditional migration patterns rather than a displacement of workers.

crops available and because cucumbers had traditionally been only one part of diversified operations. Production had required few immobile investments, allowing former growers to shift without foregoing prior investments. Their major cost was the opportunity cost of producing cucumbers compared to their chosen alternative, but this depended upon their attitudes towards risk. Cucumber production generally was slightly more remunerative to growers than alternatives, a result of processors trying to provide enough incentive for grower loyalty and cooperation.

For those willing and able to adopt the mechanical harvesters, one major benefit of the mechanical harvester was that it allowed them physically to harvest their own cucumber crop. They could now capture part of the value of harvest work themselves instead of paying workers to do the same. This also greatly eliminated the transaction costs associated with harvest, increasingly important costs when labor was scarce, when the rules of order required growers to keep lots of records on workers (for Social Security, immigration, or Workers Compensation, for example), or the method of remuneration put the burden of policing work effort on growers.

At the same time, however, mechanization increased the level of risks faced by growers. The traditional 50-50 split with labor had allowed growers to share the harvest risk, but now they bore it themselves. The scale requirements of the harvester brought with it greater grower specialization and dependence on income from cucumbers rather than a diversity of enterprises.[39] The large investment needed to acquire a harvester made it more difficult for growers to shift to alternatives, putting growers more at the mercy of the vagaries of the market.

The harvester increased grower dependence on processors, not only for the continuation of cucumber contracts into the future, but also for the relative benefit of mechanical harvesting. The economic advantage of the harvester depended upon the number of acres harvested (over which the fixed costs can be spread), a function of processor decisions. The system of year to year contracts was not formally changed, meaning growers did not have long run legal assurances of risk sharing or relative stability when making the investment decisions concerning the harvester.

Adoption was bad for growers of labor complementing crops because it further reduced the incentives for seasonal migration to Michigan, increasing other growers uncertainty about finding sufficient workers. This influence worked both ways, however, with mechanization in other crops increasing the felt need to mechanize in cucumbers. A mechanization rush

[39] Specialization still is not total. One grower with 1000 acres of cucumbers, for example, said that they only account for 20-30 percent of his operation.

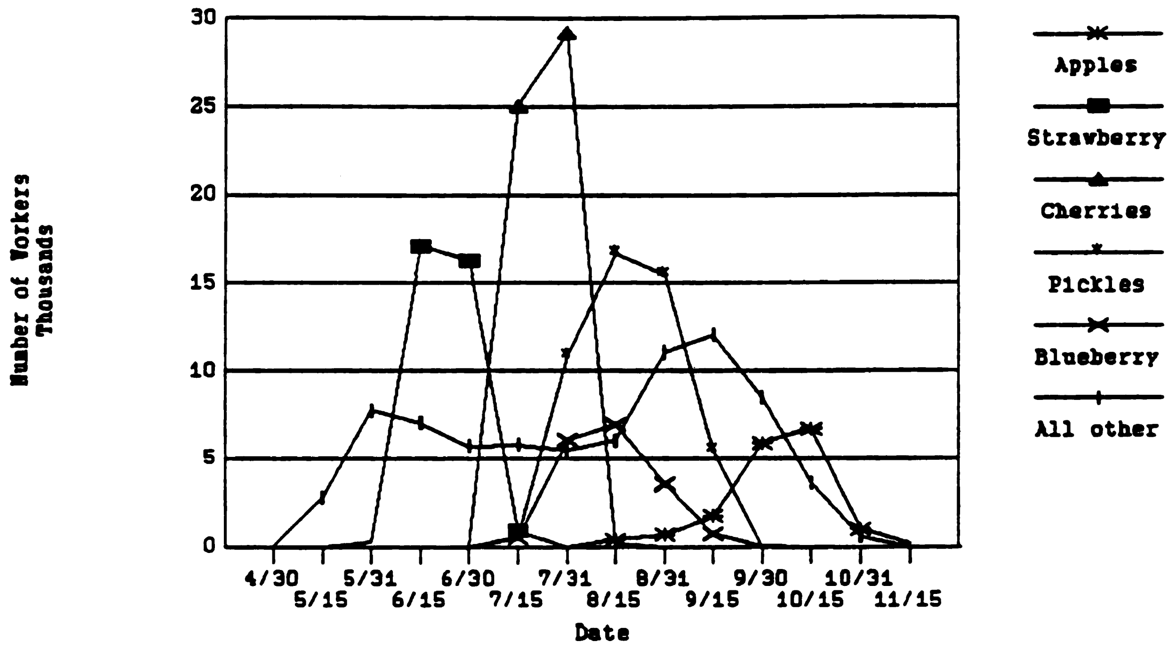

Figure 6.3 Migrant Labor Employment in Michigan, 1963

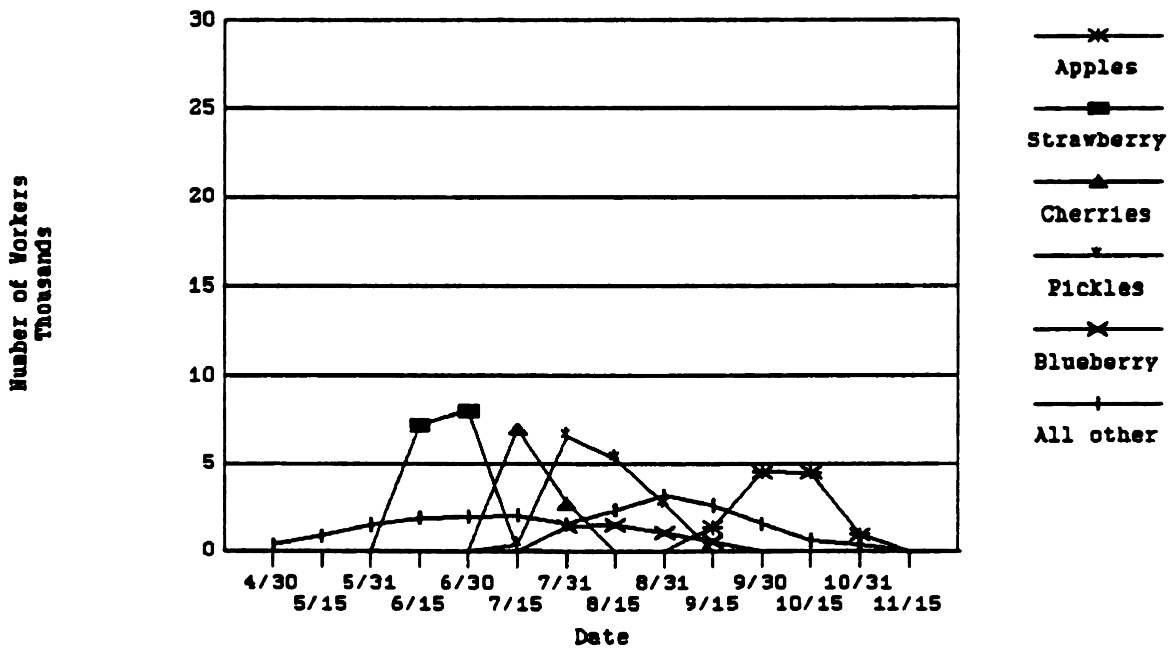

Figure 6.4 Migrant Labor Employment in Michigan, 1973

occurred during this period in most vegetable and fruit crops (See Figure 6.3 and 6.4).

Growers in Ohio and other states recipient to displaced cucumber production (primarily of the smaller grades) were presumably better off because of the harvester, even though they individually had not adopted it. The relative incapacity of mechanical harvesters to pick smaller grades of fruit, as well as the lack of adequate housing, meant some production had to shift away from traditional locations, in this case out of Michigan. If growers in these newly important areas were not better off for the change, presumably they would have continued producing their previous crops.

Even though many Michigan growers quit during the adoption years, it is not clear that "displacement" should be attributed to the machines. The impetus for mechanization was the change in the labor supply, with the choice facing many growers merely between mechanizing or quitting. Without the machine, growers likely would have had no choice.

The farmgate value of cucumber production was influenced by processor pricing decisions, which slanted grade pricing structures to be equitable for each harvest method. Hand harvested prices emphasized smaller grades, while machine harvested prices emphasized the larger grades, tending to equilibrate returns for hand and machine harvest. Equity was important because growers had other options, and processors

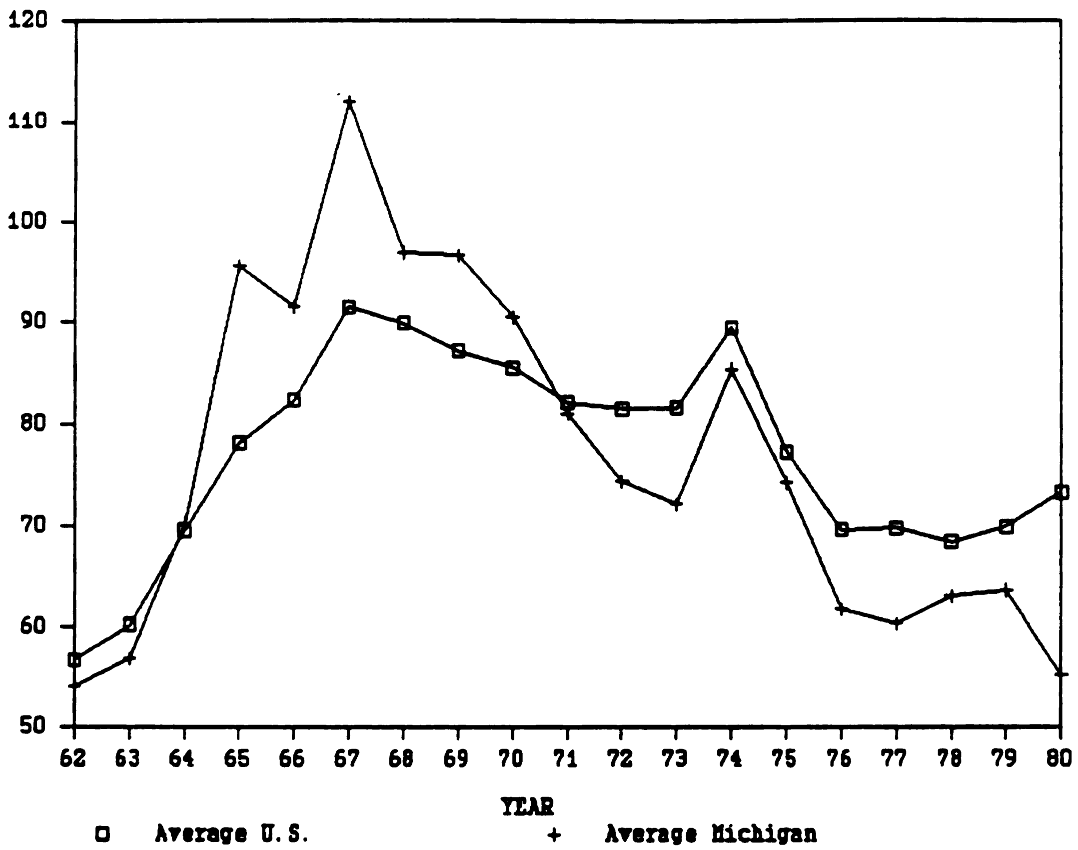

Figure 6.5 Growers' Gross Returns Per Ton

needed to make cucumber production worthwhile for them, as well as sustain grower loyalty.

Gross returns per ton for Michigan growers increased relative to the national average during the period of mechanization, likely as a result of incentives (see Figure 6.5). These dropped below the national average in 1971, when use of machines was over 80 percent, and has stayed below since that time. This is consistent with expectations, because the value of a mechanically harvested ton is less than hand harvested, even with "equilibrating" pricing. Grower returns on investment would be a more appropriate measure than gross returns per ton, but the data is not readily available.

c. Domestic Agricultural Labor

i. Level and Direction of Change

Workers were dependent upon growers of many crops for employment, because a seasonal work schedule (and total income) depended upon employment in a range of labor complementary crops. The completeness of one's schedule (few off days) was more important for income than the employment in any one crop. There were seasonal migration patterns workers followed, both geographic and crop, intended to provide full employment even though their actual employer may be different from week to week. A change in demand for labor in just one crop could have major implications for income because it could throw off the migration pattern.

Domestic agricultural workers lacked job property rights, with no guarantee of future employment or legal recourse if their positions were eliminated. The existence of their jobs was subject to the decisions of growers, beyond worker control. Workers had a similar right, however, in that growers had no legal right to workers' labor. Workers could accept non-agricultural employment without paying compensation to growers, even though that action could hurt growers.

Laws effectively undercut many interests of workers by simultaneously granting rights to growers,[40] including exemptions to many labor laws as well as allowing the temporary importation of alien workers.[41] Other labor markets, such as autoworkers, did not have to face this direct alien competition for domestic jobs or downward pressure on wages exerted by seasonal expansion of the labor force. The lack of enforcement of immigration laws allowed illegal immigrants to enter the country in sufficient numbers by the later 1970's that farm labor markets were once again attractive to cucumber growers.

Workers owned their own labor, but rules of order determined what labor could be exchanged (childrens' labor, for example), and the legal method for exchange. Labor laws, such as Social Security, Workers Compensation, and minimum wages, help define which terms of exchange are legal and which are not. The controversy with the Department of Labor involves such a concern about which exchanges should not be permitted, even if both parties involved agree to the prospectively illegal terms. Workers may still have claim to the value of their own labor, but these rules (and their

[40]With their interdependence, growers' rights to choose methods inherently conflict with workers' rights to work in cucumbers. The laws recognize the former.

[41]"In 1959, a study by the Department of Labor found that the Bracero Program hurt domestic labor" (Friedland & Barton p. 21).

enforcement) effectively influence the exchange value of that labor.

The traditional 50-50 split of revenues allowed greater chance for controlling personal returns, but also placed some harvest risk on the workers. There was no guarantee that returns to labor would even approximate minimum wages, a possibility if field quality was poor. Exemption from worker compensation laws also meant workers bore more risks of job-related injury. Growers did not bear this risk, as they would if workers were legally perceived as "employees" with all the attendant rights and privileges.

The end of the Bracero Program initially was positive for domestic agricultural workers. It was not a "problem" needing to be solved, as perceived by processors. Wage and nonwage remuneration increased dramatically from 1964 to 1965, the first year without Braceros (Mason). It was also easier for domestic workers to find employment. Domestic employment in Michigan pickling cucumber harvest increased from 3,466 workers in 1964 to 11,533 in 1965, an increase of 333 percent (MESC).

Increasing adoption of mechanical cucumber harvesters reduced this employment after a peak in 1967, however, down to 4,635 in 1972 (MESC). Employment in other crops was also declining because of mechanization, plummeting from 53,213 at peak in 1963 to 13,740 in 1973 (see Figure 6.6). The situation in cucumbers was not unique. Wages in cucumbers

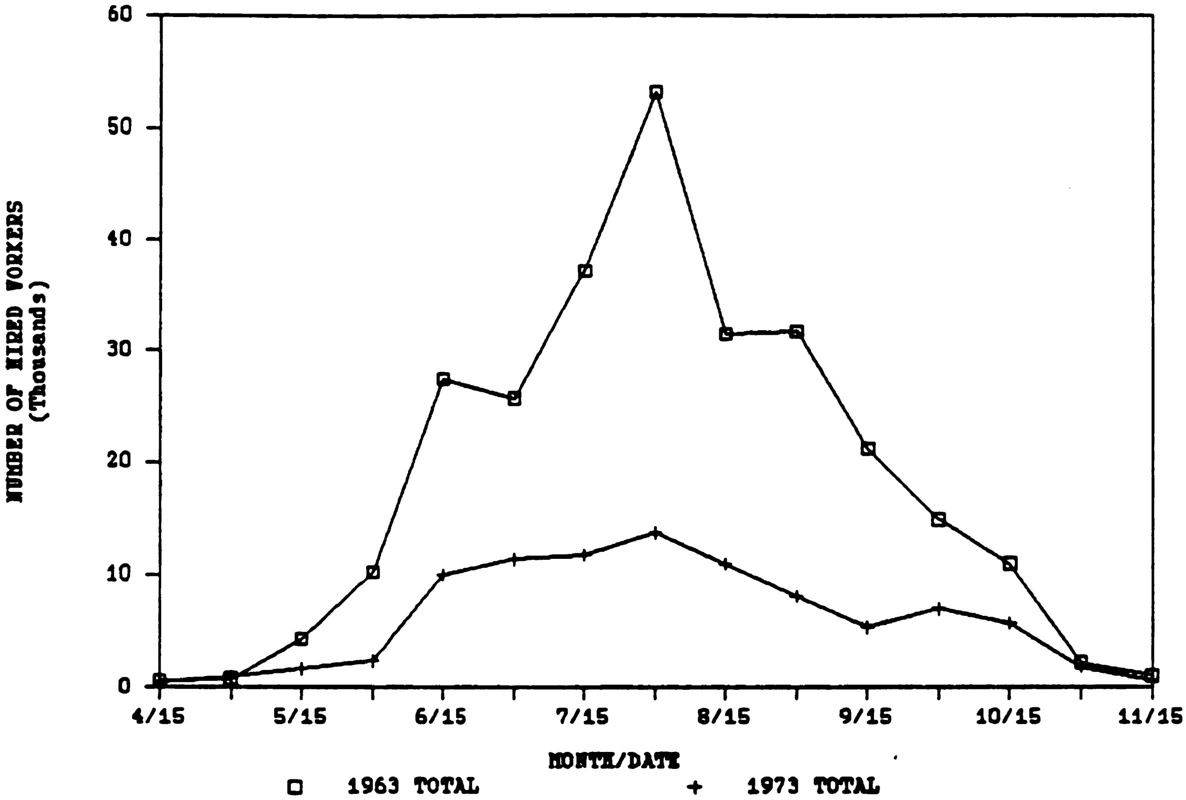

Figure 6.6 Michigan Seasonal Hired Workers

had increased from a weighted average hourly earning of $.98 in 1964 to $2.30 in 1973[42] (MESC).

ii. Division of Benefits

Adoption of the mechanical harvester did reduce employment of domestic agricultural workers. Those who lost their jobs were unable to gain compensation because they had no legal claim to employment under the rules of order.

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[42]Both in 1967 dollars. These figures do not reflect the all important nonwage provisions, so should be viewed somewhat skeptically.

Growers could adopt the labor-replacing mechanical harvesters and let the workers formerly needed but now unnecessary bear any associated costs or damage.

Compensation of displaced workers could not be forced through non-judicial means either. Workers were unorganized at this time, so lacked the political power necessary to change the rules of order. Lack of organization also made it impossible to force compensation through economic power. Workers themselves could not coerce compensation because they had little to withhold,[43] and consumers' economic power (to withhold purchases) was inaccessible because workers were not organized well enough to appeal for consumer support.

The exact level of damage to workers is hard to determine for several reasons. Cucumbers were only a small part of worker income, so the unemployment caused by mechanical cucumber harvesters only affected part of their annual income. The seasonal migratory pattern may have been disrupted, however, causing larger income effects. Mechanization was occurring simultaneously in other crops during this time period, raising problems of identification and causation for worker unemployment. Tracing individual workers is difficult because of their migratory lifestyle, making direct observation problematic. It is not clear where displaced workers went or what happened to them.

[43]Unlike the longshoremen.

Whether "displacement" had even occurred depended upon perspective: if the reference point was during the Bracero Program (it only took 7 years after the end of the program before 85 percent of Michigan cucumber harvest was done mechanically), the jobs displaced were those of the workers no longer allowed to enter the country. This unemployment would appear caused by government action, not technical change. Domestic workers could be perceived as a temporary fix of employment needs, having no long run entitlement to employment in cucumbers because historically they were not doing cucumber harvesting.[44] Similarly, a reference point after the program's termination would suggest that domestic workers were displaced by mechanical harvesting.

If adoption of the thresher type harvester occurs and domestic workers are displaced, the "displacement" here again depends upon perspective. If the immigration law reduces the supply of labor because former workers take more attractive and now accessible jobs, and adoption of the harvester occurs, is the displacement caused by those workers leaving a smaller pool for growers to hire or by growers who quit or mechanize because sufficient (or productive) labor is no longer

[44]To the extent that this shift came at the loss of employment in competing crops and not in reducing unemployment, domestic workers should have been able to return to their prior employment. An inability to return to these prior jobs as cucumber mechanization occurred, if domestic workers are perceived as such a temporary measure, reflects displacement in these other crops rather than in cucumbers.

available? Are growers perceived as damaged by workers quitting and leaving them no option to mechanization, or are workers perceived as damaged by adopting growers? Workers unable to shift to other employment or preferring to stay in cucumber production would be displaced by the change, but it is not a priori apparent who is responsible for their plight. Under current rules of order no one has a legal right to compensation.

In this context, if workers decide to seek compensation, it is likely that processors will be the target because workers have had recent success in forcing processor concessions. FLOC's ability to keep the issue of labor negotiations in the public eye and to mobilize popular support, as evidenced by the widespread boycott of Campbell products,[45] portends a potent effort if displacement occurs. This economic power possessed by the union results from their ability to convince consumers to withhold purchases rather than direct withholding of labor by union members. The success of the Campbell boycott aptly demonstrates the concern processors have with their public reputation and consumer loyalty. Demands for compensation would likely focus

[45]Vlasic is owned by Campbell Foods.

precisely upon these public reputations rather than on legal challenges.[46]

Public attention on agricultural labor displacement has been heightened by the recent University of California court case over mechanical tomato harvesters, and the longer period of time domestic workers have been doing cucumber harvesting likely gives them more moral entitlement to cucumber jobs than they had in the mid 1960's. Growers are not subject to the same pressure because their product is undifferentiated and not directly sold to consumers. Any forthcoming compensation will hence originate with processors, altering entitlements and the distribution of benefits form change.

d. Machinery Manufacturers

i. Level and Direction of Change

One impetus for manufacturers to work on mechanical cucumber harvesters was that the knowledge in a mechanical harvester would be patentable, allowing an owner of that knowledge to exclude others from its use. Patent licensing could be profitable, as could sales of a harvester when other manufacturers were legally prevented from competing.

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[46]The University of California court case focused on the use of Hatch funds during research, and the mandate for use of those funds (Hatch money was not used for the cucumber harvester). The court judgment also left labor interests unsatisfied, finding in favor of small growers instead of workers.

Knowledge is a joint-impact good, so the right to exclude others has clear distributive impact. FMC entered a research and development agreement with NPPA and MSU in exchange for the right to exclude others from the discoveries. They also agreed to produce and promote the harvester, important for NPPA because processors wanted the harvester available for use. This research and development investment was risky because it was not guaranteed that a usable machine would be developed.

Other manufacturers developed their own models in response to the research success. Mechanical patents are not perfectly inviolable, because someone can "work around" a patent to create a close but not protected substitute, obviously relying upon the patented knowledge but not enough to violate the terms of the patent. Other manufacturers likely did benefit from the FMC design even if they did not have to pay FMC for the assistance.

Even though FMC was the first manufacturer to put mechanical cucumber harvesters on the market, it quickly was surpassed in popularity by designs from Wilde and Cuke, Inc. which were less expensive (even including the tractor), reportedly less prone to breakdowns, and offered easier access to parts when repair was needed. These machines, instead of being self propelled, were tractor mounted[47] and had reinforced parts designed for heavy use (and abuse).

ii. Division of Benefits

Discovery and development of the pinch roller harvesters was especially a boon for FMC because it had been given the rights to the knowledge embedded in the machine. Research into the harvester had been directly funded at MSU by NPPA and FMC (Scott-Viner), but greatly benefited from the faculty, facilities, and support personnel at MSU paid by taxpayers.[48] MSU researchers developed the technology, while FMC was given five year patent protection to exploit any discoveries in exchange for its contribution to the research (less than $16,000 spread over three years[49]). Without this legal protection, FMC likely would not have contributed anything because the Joint Impact nature of knowledge would have made recapturing their investment difficult.

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[47]Able to take advantage of the economies of scale in manufacturing and provision of spare parts, as well as allowing farmers to maintain and repair the machine easily because of their inherent similarity to their other equipment.

[48]In a recent study, Marion, Wills and Butler (1988) estimated that funds from private industry accounted for only 11.5 percent of total research expenditures at the University of Wisconsin's College of Agriculture and Life Science, with public funds contributing 83 percent (p. 60). They concluded that university based research uses a lot of public funds, even when private funds are contributed.

[49]NPPA and FMC gave a total of $16,000. The relative share of each is unknown.

The right to exclude others from the knowledge in the FMC harvester, granted by the patent and involving relatively low policing costs because of the small number of producers, allowed FMC to capture more of the benefits than if the knowledge was common property. It was the first firm to offer a harvester, gleaning early profits. Later FMC charged Wilde with using FMC's knowledge without permission (patent infringement), ultimately collecting $41,064 in back royalties and 8 percent royalties on machines sold in the future (Cooke p. 24),[50] even though FMC's harvesters were not popular by this time.

Similarly, those manufacturers able to use the FMC knowledge without payment (whether undetected directly in their machines or to reduce the development costs of their own machines) benefited from the NPPA and MSU research without helping fund it. They also escaped the large risks associated with the initial research.

Cucumber harvesters are not high volume sales items, one reason the surviving manufacturers were small operations. Sales volume was not enough to motivate larger manufacturers to remain in or enter production. Wilde has only sold about 300 machines since production began, while Cuke, Inc. has sold about 140 since 1973. Wilde has 30 employees and Cuke, Inc. has 3, with harvester production contributing approximately

[50]The case was settled by consent in 1970.

30 percent and 30-40 percent of total business, respectively. The thresher type harvester would face no higher demand than the earlier technology. One of its designers estimates that less than 100 of the machines would meet demand for all of North America.

The older harvesters are currently selling well because of the labor market uncertainties and because the thresher type harvesters are not on the market yet. Production of the newer harvester would reduce the demand for pinch roller harvesters, eliminating sales by the two manufacturers. The value of the knowledge in pinch rollers would decline.

Cuke, Inc. would be the biggest loser because it does not have legal access to thresher type knowledge. Wilde signed an agreement with MSU and PPI similar to the early 1960's protection agreement between FMC and MSU, so would be shifting production to the new model. The potential benefits to Wilde from selling the newer model, after considering set up costs, other expenses associated with retooling, and self inflicted obsolescence of investments with the earlier harvester must be a significant barrier or production would have already begun even with the bankruptcy and reformation of Wilde.

e. Wholesalers/Retailers

The prospective changes in Michigan's supply of agricultural labor would not seriously have affected wholesale buyers of private label pickles because they could easily have shifted purchases to other regions. Transportation costs would have changed, but the plethora of states producing pickling cucumbers suggests that increased production outside Michigan would clearly have been possible.

Retailers carry thousands of products, with pickles comprising just a small percent of sales.[51] Real effects on retailers would have been fairly insignificant. Percent margins are relatively rigid, so any increased wholesale costs would have been passed on to consumers with a proportional markup, increasing retailers' per unit profits. Price spreads between brand and private label are similarly rigid, so any increases in brand prices due to an inability to escape Michigan's labor situation would be reflected in retail private label prices, even though wholesale prices of the latter would not be as affected. Retailers would thus make even more profit on private label pickles. There likely would have been a shift of shelf space towards more private label and away from brand pickles because of their new higher relative profitability. But again, because the sale of pickles is such a small percent of total retail operations, the overall effects on retailers would have been insignificant.

[51]Pickles and olives comprised only 0.40 percent of total supermarket volume in 1984 and 1986 (Progressive Grocer July 1985, 1987).

If total quantity sold changed, prices would not have played the regulating role typically assumed because retail quantity adjustments in processed vegetables occur through changes in merchandising (Hamm). Decreases in supply because of the labor situation would be accompanied by decreases in retailer merchandising of pickles, leading to smaller demand.

The influence of the mechanical cucumber harvester on retailers is thus somewhat uncertain. It helped retailers by preventing total volume from declining, but it hurt retailers by preventing wholesale prices (and thus margin profit per unit) from increasing. The outcome depends upon how much wholesale prices and per unit profits would have risen, compared to the change in total volume. Data is not specific enough to allow speculation. Nevertheless, given the share of pickles in retail operations, any effects would have been relatively unimportant.

f. Food Service Buyers

The food service industry would have been affected by the labor changes similar to wholesale buyers of private label pickles. Because their purchases are competitive and processor identity is unimportant, they would merely have shifted to suppliers in other regions. Costs might have changed because of transportation differences, or if Michigan processors were the only ones able to satisfy rigid quality specifications. Even if costs had increased, pickles are such a small percent of total food service sales that it would not impact the industry much, or make any firm uncompetitive with their food service competitors.

D. Implications of the Analysis

The major implications of the study of the mechanical cucumber harvester involve lessons both for distribution and for analysis. The case study provides a perspective of productivity different than from bGH, offering more insight into the complex process of change. It also provides another illustration of the influence of methodology and assumptions on results. Each set of implications will be discussed in turn.

1. Implications for Distribution

The distribution of benefits and costs from the mechanical cucumber harvester depended, as with other productivity changes, on whose interests and claims were effectively recognized by the rules of order. The types of interdependence present influence whose interests conflict and the relative importance of the choices of order which adjudicate those conflicts.

The interdependences (and conflicting claims) associated with the mechanical cucumber harvester are myriad (and not mutually exclusive), but most apparently consist of:

1) Growers' interest in access to sufficient workers versus workers' interest in being able to choose their jobs. Do growers have a de facto property right to labor, or do cucumber workers have the right to switch to other occupations without paying compensation to growers?

2) Growers' interest in access to sufficient labor versus domestic workers' interest in not having to compete with foreign workers for domestic jobs. This is a conflict associated with the previous conflict. The end of the Bracero Program signified a shift in the interests favored.

3) Workers' interest in employment as cucumber harvesters versus growers' interest in being able to decide the method of production. The adjudication of this conflict helps determine who bears the cost of any unemployment resulting from adoption of the mechanical harvester. If workers have the right to be employed in cucumbers, growers would have to purchase that right (through exchange or compensation) to mechanize, while if they did not workers would have to bear the costs of unemployment without compensation from adopting growers.

4) Workers' interest in harvesting cucumbers versus growers' interest in harvesting cucumbers. This is closely related to the preceding conflict, but directly concerns who has the right to claim the value of harvest work. The mechanical harvester allows growers to do harvest work and thus make claims on the value of harvesting, as well as reduces the transaction costs of harvest (eliminates the transaction costs of hiring workers and policing work effort). If workers have property rights in cucumber harvest growers must still purchase this right from workers even though the mechanical harvester by itself physically gives growers the ability to claim the value of harvest work.

If workers do not have the right, their claims on harvest are effective only as long as growers decide to accept those claims in exchange for harvest work. Before the mechanical harvester growers had no choice but to accept workers' claims, but the mechanical harvester physically gives them that choice. The rules of order influence whether they can (and will) take advantage of that possibility.

5) Interest of growers in producing cucumbers versus processor's interests in deciding with whom they contract. Whose interests are favored by the rules of order affects whether processors can require growers to adopt mechanical harvesters, as well as the incentives for growers to conform to processors' specifications.

6) Processors' interest in access to sufficient growers (acreage) versus growers' interest in being able to choose alternative crops. Do growers have the right to shift to other crops, even if that will create losses for cucumber processors, or do they have to purchase that right away from processors? Currently growers have the ability to change without paying compensation. Processors purchase short run grower guarantees (production contracts) but these only cover one year. Because processors must "buy" the right each year, they have to offer incentives sufficiently better than grower alternatives to keep growers producing cucumbers.It also means that when labor became unavailable after the Bracer Program termination, processors had to find another attractive method of harvest to prevent growers from quitting production. If instead growers had to buy the right to change (either through exchange or compensation), they would have faced greater incentives to bear the costs of research and development and processors would have been less threatened by the relative lack of labor because they would have at least received some compensation for any immobile investment losses.

7) Rights to knowledge (joint-impact nature of knowledge in the mechanical harvester). The knowledge embedded in mechanical harvesters is a joint-impact good, with a negligible cost of marginal use. The ownership of the knowledge (as well as effective excludability of that knowledge) has clear distributive impact. The public helped fund the research and development of the harvester at MSU), while the patents were given to FMC in exchange for guarantees that the harvester would be produced and sold. FMC benefited because they had exclusion power over the knowledge, and were able to be the first firm to sell the harvester as well as elicit compensation from Wilde for use of the knowledge. Other firms undoubtably benefited because of the high policing costs of mechanical patents. They were able to benefit from the FMC owned knowledge even if they did not copy it exactly, while simultaneously avoiding paying for the use (as well as for the knowledges creation).

8) Ownership of incompatible-use goods. Ownership of the mechanical harvesters, land, processing plants, and units of labor (hours or effort) is important because it affects actors' relative opportunities (especially in the presence of transactions costs). The adjudication of conflicting interests about the machines, land and processing plants is not very obvious because it has become part of the status quo, but the conflict about rights to (endorsement of) labor is clearly evident.

> At issue with the Department of Labor's court suits is the exchangability of one's own labor, including who can sell their labor (children?) and the permissible terms of such exchange. Should children be "protected" from manual labor (until what age)? Can an adult voluntarily exchange their labor for less than a minimum wage, for a 50-50 split, or for a package of remuneration which does not include workers compensation, Social Security, or minimum work environment standards? This has implications for worker incentives (as growers are aware) as well as for distribution. Rights to the mechanical harvester, land, processing plants, and the other incompatible-use goods present equally reflect such adjudications even if they are not as obvious.[52]

The market context, in which actors make production and consumption decisions, is a function of whose interests are favored during the adjudication of these conflicts. These structure and provide actors' opportunities and incentives for action. Processors played the pivotal role of instigating research into mechanical harvesters because under the rules of order they would have had to bear the entire loss of their large immobile investments which would result if workers and growers quit production. Processors could not prevent workers or growers from quitting, nor force compensation for losses.

Simultaneously, workers and growers (while facing different opportunities and incentives) did not have to consider the resulting losses on others from their actions. The research was intended to provide an alternative attractive

[52]Not as obvious because they are customary and not usually challenged or questioned.

harvest method to growers, which when combined with processor provided incentives would keep growers in production and processor investments safe.

FMC agreed to bear some risks of product development and marketing in exchange for exclusion power over the techical knowledge in the mechanical harvester. Without this patent protection they would have had less incentive for taking the risks. Other firms benefited from FMC's work, not only through the knowlege but also from the clear information that there was a market for mechanical cucumber harvesters, and thus greater potential for recouping proprietary development costs.

These elements by themselves are not enough to explain the exact level of income received by each actor, but they are enough to describe the market context (including incentives and opportunities), the behavior of different actors, the events which occurred, and the basis of claims on income form change. Consumption and production decisions occur within this context, interacting through supply and demand to determine the specific values involved. Without the prior decisions of order (explicit or by default) which adjudicate the conflicts, however, supply, demand, and relative prices have not meaning.

2. Implications for Analysis

The assumptions used during analysis influence the results, as occurs with Neoclassical studies. The choice of relevant actors affects whose losses and gains are recognized in the analysis. The speculative judgment about "what would have happened" influences interpretation of actual events. Most importantly, the focus on actors' interdependence and entitlements yields conclusions less straight forward but more rich than with a price-based focus. Each will be discussed in turn.

The choice of relevant actors is important. Cooke's (1985) study of the mechanical cucumber harvester focused on consumers and owners of factors in fixed supply, but without identifying this latter group or factors. Other actors, such as laborers and displaced growers, were discussed in brief but not as central foci. Estimating or explaining the distribution beyond the two major aggregations was impossible. As Cooke admitted, his approach "limits the possibility of disaggregating the returns beyond the simple dichotomy of final consumers and resource owners" (p. 237). Findings of benefit or damage were limited to these groups.

At the other extreme of explanation, focus on <u>all</u> the interdependencies involved with the harvester would allow more precise disaggregation, but only with concomitant problems of data availability and eventual triviality, because it would necessitate considering an infinite number of actors and ranges of interdependence. A middle path was deemed more appropriate here, concentrating upon the major actors and interdependencies while simultaneously recognizing that other actors and effects are being neglected.

There are several "what would have happened" possibilities. The first was that mechanical harvesting helped keep harvest costs from climbing because of labor shortages. The harvester benefited consumers by keeping prices at the "normal" level: processors would have had to offer higher prices to growers, and then pass these along to consumers. The harvester also would have benefited wholesalers/retailers and food service by providing them with product at usual prices. Labor lost because the machines kept wages from rising. But these price effects would have been small because of the relatively small contribution of Michigan to national production.

The second is similar, but asserts that the harvester not only kept costs from rising, but reduced them in real terms. This is Cooke's argument, but it does not appear supported by most cost of production studies (at least over the late 1970's and early 1980's). If such a reduction _had_ occurred, consumers would not necessarily have reaped the benefits typically assumed because the structure of the market does not approximate perfect competition. Processors set farmgate prices, but would be relatively unable to capture all the benefits. Processors _could_ adjust prices lower to capture some of the benefits of the technical change, but they need grower cooperation and loyalty to avoid the high policing costs associated with product quality (policing internal damage, conformity to company cultivation practices, etc), and price reductions could easily be seen by growers as a violation of reference transactions.[53] Retail pricing procedures, with fixed margins and downward price rigidity, further diminish the prospect of benefits reaching consumers in the short run.

The focus on price effects, however, likely discounts the major benefits arising from the harvester. The crucial benefits associated with the cucumber harvester are not simply price changes or rents, but the composition of <u>who</u> was able to produce. Wholesale purchases of private label product and food service industry buyers could have shifted product acquisition to processors in other regions not as impacted by the labor changes, and brand label producers could have similarly shifted without major changes in costs. Michigan is a major producer of pickling cucumbers, but only accounts for 20-30 percent of national output. The harvester, more than anything, allowed Michigan-based processors to continue production and Michigan growers to have the option of growing cucumbers. It meant the survival of the pickling cucumber industry in Michigan, a fact more important to those it kept

[53]Moral entitlements, as discussed in chapter 4.

in production than any effect it had on national prices and without which adoption appears illogical.

This conclusion is more apparent from the Entitlement and Productivity Framework because of the framework's focus on the interdependence between actors. Relative prices are important, but of equal importance is the basis of the entitlements to those values and how these effective entitlements are involved with the productivity change. The effective entitlements are created by the interaction of interdependence and rules of order. Relative prices only arise within this context, reflecting, in part, whose interests are expressed (and whose are not) in the rules adjudicating interdependence. To describe the process of technological change as a reflection of relative prices misses the complexity (as well as potential analytical richness) of productivity change and income distribution.

Chapter 7

Conclusions

The study of productivity change and income distribution is difficult because such change is a complex as well as divisive process. There are a potentially large number of elements worthy of inclusion in analysis, with the selection affecting the results. The complexity makes the methodological and theoretical choices required of the analyst even more important and influential. Productivity change has disproportionate effects on different types of actors, and analysis of change unavoidably legitimizes some claims consequent to change while simultaneously denies other.

This dissertation has attempted to discuss and illustrate some of these analytical choices and influences. A framework for analysis has also been developed and tentatively applied, offering different perspectives on productivity change as well as further illustrations of the influence of the approach on results. The conclusions will review the impact of the nature of science on analysis, before discussing the direct problems of analyzing productivity change highlighted and implicit in the dissertation. This latter discussion will include consideration of the appropriateness of Neoclassical and the Entitlement and Productivity approaches.

A. Nature of Science

Science is not wholly objective because the observer unavoidably influences what is discovered. Nothing is known independently of the knower, meaning that knowledge about social relationships (like economics) is never separate from the experience of the knower as a participant in that social system as well as experience as an observer of that system. This arises because human perception is a product of culture, experience, and expectations, and because value choices are necessary for scientific research to occur. Even relatively observable data like "costs" are a subjective concept because they interpret which of the ubiquitous injuries from interdependence are relevant, thus recognizing some claims while denying others.

Kuhn and others argue that science is paradigmatic, in that the world is experienced and interpreted by scientists from within a world view rather than from an entirely objective perspective. The paradigms structure experience and provide the hypotheses tested by science, but because they help provide the interpretation to what is observed, they are not open themselves to direct testing or refutation.

Choice between alternative paradigms is not possible through scientific means. Econometric tests, for example, check whether some explanation arising from an accepted paradigm[1] is plausible in light of experience (experience structured from within the paradigm), not whether the paradigm is better than another paradigm. They attempt to compare alternatives within a paradigm, not the paradigms themselves. Equally plausible explanations for the same event are possible from other paradigms, but are not checked nor shown to be inferior (or superior) to the econometrically tested explanation.

The choice of paradigm is crucial for the results from research, but is dependent upon the researcher's judgments. Accepting the status quo or mainstream paradigm does not absolve the analyst of a judgment because the choice still makes the approach as subjective as the societal decision rules making the paradigm predominant.

Similarly influential choices must occur once a paradigm has been accepted. These include the theoretical judgments about the specific experiences from within the accepted paradigms, and the interpretation of the experiences. The theoretical judgments are the practical choices about boundaries of study, causality, and numeraire, including the specific definition of income, productivity, efficiency, injury, bad luck, and other concepts which help demarcate the subject. Interpretation includes the significance of results

[1]Accepted by the econometrician.

("is X different from Y?") and the normative interpretation of those results ("is the difference good or bad?").

The "problem" studied is a subjective choice as well, because it implies an objective which is either not being fulfilled or is being accomplished with perceived inefficiency. In a world of interdependence and conflicting interests, problems are not neutral; a problem for one person is a benefit for another. The Lords' difficulties in collecting their share of grain because of hand milling, in Marglin's Handmill-Watermill case, was a benefit for the peasants who saw no problem with the system. The relative shortage of labor which spurred development and adoption of mechanical harvesters (tomato and cucumber) was a problem for growers and processors, not for those migrants still in the labor force. The possible "incentive problem" if the 50-50 split between cucumber growers and harvest labor is eliminated is a problem for growers and high productivity workers, not for lower productivity workers or those workers who would enjoy working at a more leisurely pace (or enjoy shirking).

These necessary choices by the researcher raise inherent conflicts of interest, because most economic research is conducted by members of the system under analysis.[2] Researchers are not entirely dispassionate because they are intrinsic

[2] I am not a member of the cucumber or dairy subsectors, for example, but I am a member of the U.S. economy in which these are subsets.

parts of the economy (not only in their role as economists), and thus possess inherent experiences, interests and biases as participants in that system which can influence choice of problem, observation, and approach. This does not mean economists manipulate theory to serve or exploit their own interests, but only that they inherently identify more with some claims than with others.

The necessary choices further means that analysts are forced to take sides whether consciously or by default, especially if the research is problem solving. The choice of appropriate variables, boundaries, numeraires, and their accompanying labels arbitrates between conflicting interests and offers legitimacy to those claims it recognizes. With interdependence claims are ubiquitous and conflicting, so recognizing one claim inherently denies another. This is problematic because economics influences the social order it examines by helping define public debate and presenting options.

B. Analyzing Change

1. Neoclassical Theory

Neoclassical analysis is deductive, using logic to derive conclusions from starting premises. The conclusions are then sometimes tested against observations of the real world. The conceptual framework is crucial because it determines how the world is perceived: what elements are worth considering and those outside purview. This choice of elements unavoidably is based on values instead of scientific choice, and because it is not the object of study is not open to scientific refutation.

Deductive approaches require relatively small conceptual models to be practical.[3] Taking the institutional context as exogenous, as done by Neoclassical approaches, limits the number of choices available to actors (typically consumption and production) to a number reasonably handled by the models. Allowing actors to change the context would cause difficulties because the definition of the variables (demand, supply, prices) would be contingent upon choices, and the range of possible behaviors would make the model unmanageable.

Neoclassical analysis is primarily focused on in-market behaviors, such as consumption and production, within a context of institutional choices which are taken as exogenous. Even the more institutionally astute Neoclassical theories like Induced Innovation and Transactions Cost Analysis have primarily an in-market focus. Induced Innovation Theory posits that the direction of institutional or technical change is induced by relative prices, even though relative prices must be preceded by the institutional context because they unavoidably reflect that context. The Transactions Cost Analyses (such as Williamson's) focus on how institutional

[3]Small in the number of possible actions or choices, not in the number of participants or interactions.

rules affect transactions costs and the ultimate allocation of resources, but do not deal completely with the initial endowment of goods and thus incidence of transactions costs. Both types of theory illustrate important elements in the economy, but they are limited to analysis within a given market context instead of explaining that context itself.

Actors do respond to relative prices, transactions costs affect the allocation of resources, supply and demand interact to determine many relative values, and marginal adjustments are important within this market context. Neoclassical approaches are useful for discerning and discussing these relationships, as illustrated in Chapter 2. Productivity change and income distribution, however, arise from more than just in-market behaviors. Actors attempt to change the rules of organization, exchange, or endorsement, and create new production relationships through research and development. Supply, demand and relative prices occur after these decisions have been made, so focus purely on in-market decisions misses some of the complexity involved.

The limitation to in-market behaviors has implications. The choices highlighted by Neoclassical economics are those within the narrow confines of the market context, a focus which during prescription legitimizes (whether consciously or unconsciously) the context and draws attention away from the equally vital and influential decisions about that institutional context which affect distribution. "Free

Markets" are not those existing without rules and regulations (an impossibility) but only those without change from a set of reference entitlements. "Regulation," as used in most Neoclassical analysis, only makes sense in relation to a set of reference entitlements because markets by nature are created from rules and regulation. These favor the interests of those well off under the status quo at the expense of those who would be better off if the status quo were changed. It also misses the dynamic nature of change.

Neoclassical income distribution theories, like Marginal Productivity, reflect this bias towards the status quo. The influential relationships they discern for the distribution of income are those within the market context, not those of the context itself. These commonly include consumer preferences as weighted by given endowments, the supply of factors as affected by given endowments, and the technical substitution between factors. That changes in endowments affect economic performance and income distribution should be clear from this theory (both demand and supply are functions of endowments), but most income theory does not go beyond simple recognition that institutional impacts are important.

If the theory is used for prescription, this legitimizes the status quo and turns attention away from how changes in the market's institutional context would affect income distribution. Explicit examination of the role of the institutional context would imply doubts about the legitimacy of the status quo. Focus on in-market choices at the expense of attention to contextual (institutional) choices limits policy responses by not articulating the full range of options available to decision makers, effectively protecting some interests. If the role of economics is legitimization this may be proper, but if the role is to help policy makers see the options it is incomplete.

2. Entitlement and Productivity Framework

The Entitlement and Productivity framework developed in this dissertation obviously does not escape normative judgments either. The choice of paradigm as well as relevant classifications within the approach has implications for results as strong as with Neoclassical approaches. The approach attempts to be inductive, with the four major categories (order, method, knowledge, and production, consumption, and effort) and variables intended as loose guidelines for observation instead of providing rigid categorization. These do influence perception of change, and thus results.

Consideration of the market's institutional context does not necessarily connote a normative judgment in favor of changing the status quo, but it does implicitly judge that such change is a possible alternative. The approach does not attempt to predict what will or should be done, nor provide normative interpretation of the possibilities, so it does not explicitly attempt to decide between conflicting interests even though implicitly this occurs through recognition of problems and theoretical choices.

a. How it Differs from Neoclassical Approaches

The Entitlement and Productivity Framework operates at a different level than Neoclassical approaches, including Induced Innovation and Transactions Cost analyses. The focus of the framework is on the origin of relative prices and institutions, not just on how existing relative prices influence research, investment, and adoption decisions, or on how transactions costs under existing institutions affect incentives for institutional change and the final allocation of resources. These latter are important, but by themselves do not explain the black box of entitlements which give definition to the context in which relative prices and transaction costs have meaning.

The framework attempts to investigate the dynamics of income distribution and productivity change by more directly considering the creation, adaptation, and role of entitlements. The approach is not inconsistent with traditional economics, and easily can be viewed as an attempt to push traditional economics into dynamics. Economists commonly say that prices reflect preferences and other market information, so this approach attempts to provide a systematic way of looking at the basis of prices.

This area has been treated as a black box by Neoclassical economics. Relationships like factor substitution are important to know, but focus on them (as in traditional economics) begs the question of how these relationships are determined and where the effective claims come from. Relative prices as an explanator do not explain the origin of the specific claims, and transaction costs do not explain the initial effective claims which affect the incidence of the costs. Delving into the dynamics, and thus looking directly at these, gives a more complete understanding of how the economy functions. It highlights a fuller range of choices involved in productivity change and income.[4]

Instead of simply describing the market context as the "initial endowments," the Entitlement and Productivity Framework investigates the context more completely. Premised on the conceptualization of markets as sets of rules and regulations which adjudicate conflict, the approach sees "endowments" arising from the type of conflict in a situation and the specific rules adjudicating that conflict. Official rules may be ineffective, for example, depending upon the type of interdependence present. There are two general types of interdependence (and conflict) of interest, situational interdependence and technical interdependence.

[4]As opposed to the traditional focus on "what will be chosen," usually meaning just production and consumption.

Situational interdependences, inherent in the nature of goods, are unchangeable. These have been categorized by Schmid (1987), and include incompatible-use goods, high exclusion cost goods, economies of scale, joint-impact goods, transactions costs, surpluses, and demand and supply fluctuations. The type of situational interdependence present determines which market rules are influential for actors' opportunities and income; ownership of a good may be important when a good is incompatible use, for example, but it is less so when that good also bears high exclusion costs. The interaction of the situational interdependence and rules determine the effectiveness of those rules, as well as actors' access to goods and effectiveness of their claims on income from those goods.

Technical interdependence arises after the effective access and control of goods has been determined by the interaction of situational interdependence and rules. The order consequent to this interaction combines with the possible methods of production (relationships of needed inputs to outputs) known at any time to delineate who must deal with whom for production of a good to occur. It is this context that provides the opportunities and constraints faced by actors (including effective claims on income), within which they make production and consumption decisions. Supply, demand, and relative prices only have meaning within this context.

Productivity change can occur in several ways from this perspective. The rules of order (adjudicating the situational interdependence) can be changed to endorse (or unendorse) an input or output, changing the relative advantage of the status quo method of production, or the rules can be changed to alter effective control of goods, with similar effect. Both can provide enough incentive for an actor to choose an alternative method of production. The state of knowledge (which specifies the known and available methods of production) can be changed through research and development to offer a new, more attractive (under the existing relative prices) method of production.

The choices available to actors which influence their income are more than production and consumption under this framework. Actors can change the market rules (order) to redefine who can participate (and how), changing the number of competitors or suppliers. Rule changes can be done to alter the definition of product or factors to receive compensation for some taking, to allow themselves to take from others without paying compensation, or to change the legality of a particular production method. Actors can change the state of knowledge to create a new competitive production method either more dependent upon factors with entitlements they hold or an input not requiring remuneration for use under the status quo order, or less dependent upon an input or factor to which they do not have ready access or control.

They can switch to an alternative (but already known) method for similar reasons.

The market context is manipulated most apparently through attempts to define problems and to change rules, including incidence and recognition of costs (endorsement of factors and product). Actors do not constrain their choices to production and consumption decisions, but are clearly able to change their entitlements as well as the value of those claims.

Actors influence the direction of change by helping define the "problems" (unsatisfied interests) needing attention and solution. This arises both through recognition and definition of the problem, and through affecting the direction of research and solutions. These are power issues.

Tomato growers were able to make the potential demise of the Bracero Program a "problem," even though it was no problem for domestic migrants who would face less competition for harvest jobs. Cucumber processors did the same in Michigan. Dairy farmers have been able to define the potential elimination of price supports and loss of immobile assets as a "problem," one reason policy makers attempted to reduce the level of government expenditures on dairy through the "buyout" of farmers' claims instead of simply ending the program as is the usual procedure with the termination or reduction of government transfer payments. These were actual (or potential) problems faced by the actors, so their concern was not artificial or manipulative. But by bringing recognition to their injuries it simultaneously diminished recognition of the value of the concomitant benefits accruing to others.

Research to solve "problems" inherently reflect this subjectivity. Both the perceived problems and direction of solution in research are elements of choice, influenced by actors who either do the research themselves or influence the direction of others' research. The university research involved in each of the case studies, for example, was influenced by actor-provided funds, affecting the direction of publicly funded research. This occurred with bGH (Marion 1988), the tomato harvester (Hightower), and the cucumber harvester. The prospective end of the Bracero Program was not a problem for domestic agricultural workers, but it was for growers and processors, who were able to get public research help to solve it. Research is a strategy by actors to affect their income.

Rule changes, including endorsements, are also frequent actions by actors intended to affect entitlements and income distribution. The creation and demise of the Bracero Program, anti-trust enforcement under the Sherman Act, the Capper-Volstead Act, and exemptions for agricultural labor in worker compensation laws are examples of how political power was used to influence the distribution of income. Court cases are also used, such as with mechanically deboned meat, the court case against the University of California because of the mechanical tomato harvester, and the Department of Labor's cases against cucumber growers. Other actions include behaviors such as FLOC's boycott of Campbell Foods to gain recognition as a union, pickle processors' transfer of responsibility for housing and recruiting labor to growers, and California milk consumers implicit threats to retailers carrying bGH milk.

Supply and demand occurs only within this context, after rules have influenced who can express preferences, who are suppliers and who are demanders, and actors have chosen their preferred method(s) of production. The prior choices of order, state of knowledge, and method of production give definition to the choices of production and consumption typically studied in traditional economics.

The framework makes several things obvious about productivity change and income distribution. Firstly, the manipulation of the market context is an important determinant of what occurs and how benefits and losses are distributed, a fact well recognized by the actors and discussed previously. Secondly, "productivity" is preceded by the effective entitlements which endorse factors and product as well as establish the structure of incentives. Productivity is a dependent variable, not exogenous.

Entitlements must precede productivity, because the incentives for effort and definition of productivity arise from the market context. Productivity is thus also subjective, depending upon which interests are deigned important. The value of shirking, for example, is typically not included in measures even though it does have welfare implications. The productivity advantage of watermills arose, in part, because the grain that peasants were able to withhold was not recognized as a good, favoring the Lords' interests over peasants' interests.

Examples from the case studies further illustrate this. The perceived productivity of the mechanical tomato or cucumber harvester depends upon whether displaced workers or adopting growers pay the cost of worker displacement. Changes in worker compensation or migrant housing laws, altering the entitlements of workers and growers, affects the productivity of hand harvest through incentives and definition. The endorsement of bGH milk as identical to or separate from non-bGH milk has obvious effect on productivity. The judgment from the University of California court case, asserting that social impact assessments be done before mechanical research is conducted adds some displacement costs to the calculation of productivity. Cucumber processors pushed adoption of mechanical harvesters after the Bracero Program ended, even though the mechanical harvesters produced lower yields and economic returns per acre. Productivity is not an objective measure, but reflects choice (conscious or by default) between conflicting interests.

An obvious implication of this is that the level of income does not depend upon productivity, as implied in

Marginal Productivity Theory, but also depends upon the market context which recognizes some claims on the income stream while denying others. The perception of "productivity" or "contributions to production" arises out of the institutional adjudication between conflicting claims (of which takings or injuries are compensable). The accepted claims and productivity may appear identical, but this occurs because both receive meaning from the same institutional context, not because of a causal relationship between the two.

The results from analysis with the framework are less concise than with some other approaches, but the intent is description, not prescription. The range of choices described does grant more options to policy makers, at the same time it does not attempt to provide normative interpretation of the results and thus suggest the appropriate policy response. It is less value-imperialistic than approaches, such as Economic Surplus, which contain more hidden interpretative value judgments. It can help lead to compromise or resolution of a policy conflict, because it illustrates the conflicting claims present in a situation, making it easier for all parties to see others claims. The approach does not give an answer (i.e. "what to do"), however, leaving it up to the participants to find their own solution.

b. Case Studies

The case studies developed in the dissertation are interesting because they illustrate some of the difficulties involved in analyzing productivity change as well as offer insights into how the institutional context influences the distribution of benefits. They highlight some of the types of distributive choices involved in change, as well as the usefulness of the Entitlement and Productivity Framework.

The major situational interdependence in dairy is the seasonal fluctuation in production, exacerbated by the inelasticities of demand and perishability of product. Market Orders determine who bears the cost of this fluctuation, by creating price classifications and Class I differentials to induce a fluid reserve, and by stipulating market rules of exchange. The Federal price supports add an element of stability as well by guaranteeing farmers a floor price on production.

Synthesized bGH was created by those hoping to obtain a claim on dairy production in exchange for increasing the level of the income stream from that production, instead of by farmers attempting to increase the value of their own claims. BGH is a complement to the other inputs already used in dairy production, not a replacement for some inputs, as long as the support and stability programs remained fixed. Adoption will not effectively deny other claims (by making some inputs obsolete), but it will increase the size of farmers' claims on the price support program. The prospective level of these claims under current rules makes it likely that the political support for the current rules will become unsustainable, and the rules of order will be changed. If and when this happens, bGH will substitute for other inputs and influence their claims on income.

There are also other questions about whose interests should be favored regarding bGH which require resolution (explicitly or through default), most apparently how bGH-produced milk will be identified to consumers. These decisions must be made one way or another, likely with very different distributive consequences.

The bGH case study's focus on entitlements (instead of on just the value of entitlements) allowed these types of choice involved in change to be discussed. The range of policy options involved is more than the adjustments in support prices many analysts discuss, and actors' choices are about more than consumption and production. The structure of market relationships, as created by order, the state of knowledge, and choices of method, is itself an integral variable affecting the distribution of benefits which is manipulated by the actors.

The bGH case study also showed how limited an inductive style approach is when considering future changes. The Entitlement and Productivity Framework can illuminate some of the relevant choices, a benefit for policy analysis, but its lack of a deductive behavioral model prevents prediction of the total size of benefits and the level of different actor's claims.

One of the major situational interdependences in pickle production is the seasonality of cucumber production, causing fluctuations in demand for cultivation, harvest, and processing. The seasonal need for harvest labor had been met by the Bracero Program, which temporarily brought agricultural workers into the U.S. to harvest cucumbers (and other crops). This had allowed growers relatively guaranteed access to labor when they needed it, relatively stable harvest costs, and buffered them from fluctuations in the domestic agricultural labor force. It also reduced the comparative bargaining position of domestic workers interested in cucumber jobs, and likely reduced their income.

The termination of the Bracero Program in 1964 changed the order of the market by redefining who could harvest cucumbers. The relative wages of hand harvesters of cucumbers increased because the supply of workers had been decreased, and the uncertainty about timely grower access to needed workers increased greatly. The risks of access were high because growers and processors had immobile investments in cucumber production dependent upon harvest capability.[5]

[5]At least in the short run for growers, who obviously must plant the crop before the workers come to harvest.

The change in harvest costs and the increased uncertainty and risk provided the incentives for adoption of mechanical cucumber harvesters. This was a response to relative prices, but the relative prices changed because growers entitlements to a steady supply of workers (through the Bracero Program) had been terminated. Using relative prices as the explanator limits understanding of events by foregoing the causes of the price changes.

The creation and adoption of mechanical harvesters altered the technical interdependence between actors. With the machines it was no longer necessary for growers to depend upon agricultural laborers, reducing workers' ability to price bargain and increasing the options of growers. The new method of production effectively took away workers' ability to work in cucumbers, unlike bGH which may not replace an input(s). It was a benefit to growers and processors, but not to workers.

The recent slow change back to hand harvest does not diminish the effect of the harvester on opportunity sets. The mechanical harvester, even if unused, provides a safety valve for growers and processors in case workers become relatively unavailable or if worker bargaining strength (through unionization or other means) increases enough to make hand harvest too costly. Renewed industry interest in mechanical harvesting because of the recent developments in the cucumber subsector (immigration law changes, Department of Labor lawsuits, and unionization of workers) illustrates this.

Similarly, the adoption of mechanical harvesters was important not for its price effects (consumers did not benefit much) but because it enabled Michigan processors to survive and produce. The study also illustrated the difficulty (subjectivity) of determining displacement and damage, because these depend upon whose interests are recognized and whose are not. Whether domestic agricultural workers were displaced by the first harvester depends entirely upon judgments of whether they had a claim on employment in cucumber harvesting.

c. Use of the Framework

The Entitlement and Productivity Framework must be situationally applied, tailored to the specific circumstances of the case under study. The circumstances determine the interdependences and conflicts present, the specific rules important for delimiting opportunities and entitlements, as well as how the productivity change occurred.

The conceptualization of productivity change and income in the framework involves four general types of choices (choices of order, choices of method, choices of the state of knowledge, and choices of production, consumption, and effort), but these must be subsumed during analysis into eight general concerns.

1) Determine the situational interdependence involved. These inherent conflicts imply the rules of order important for distribution and for actors' relative opportunities.

2) Determine the rules adjudicating these interdependences, and whose interests they favor. The rules include demarcation of actors (who can participate and how they can organize), ownership of incompatible-use goods, exclusion costs, who chooses joint-impact goods, pricing rules, incidence of transaction costs, and endorsement of factors and product, among others. What are the effective entitlements under these situational interdependences and rules?

3) Determine the methods of production (for the good under study) available under the pre-change state of knowledge, as well as the inputs required and the outputs produced under each alternative method.

4) Determine the technical interdependences (who has to trade with whom) between actors, relationships dictated by the interaction of the known methods of production (which inputs are required and outputs produced) and the pre-change status quo rules of order and situational interdependence (which determines effective access and control of these inputs and outputs).

5) Note the supply and demand within this context. What are the relative values of entitlements, the relative prices, and balance of economic, political and administrative power? Actors' incentives for changing production, consumption, or effort decisions? Incentives for altering other decisions (as well as ability to change these)?

6) Determine the specific change which occurred, as well as who was instrumental in fomenting the change (and who either tried to prevent the change or induce a different change). Was it a change of order? Change of methods used? Change of the state of knowledge to allow adoption of a new method? What are the new effective entitlements (including "compensation")?

7) Determine the new technical interdependence between actors, under the (new[6]) rules of order and situational interdependence, and the (new) known methods of production.

8) Note the supply and demand within this new context. What are the relative values of the entitlements, relative prices, and balance of economic, political, and administrative power? Actors' incentives?

C. Implications

Analysis of productivity change and income distribution is difficult. The necessary value choices required means that analysis can never be more than a subjective procedure, influenced by the value judgments of the researcher. There is no clear or objective answer to how it should be researched. The appropriateness of an approach depends upon the story the individual wants to tell rather than an objective theory of science. The analyst's interpretation lends legitimacy to whoever's perspective is mirrored, whether consciously or by coincidence.

The perceived role of economics also makes a difference: whether economics is meant to illustrate all the allocative and distributive choices available, to justify or legitimize some value judgments about economic rules or conditions (such as supporting the status quo), or to find options only within a narrow context. This is a value choice, whether based upon strength of numbers ("it is the mainstream approach") or some

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[6]New if this is where change occurred.

other equally arbitrary decision-rule. Accepting a decision-rule does not abrogate the judgment about whose interests are deigned important, because such rules themselves judge whose perspectives are important and whose are not. A value judgment which favors some interests at the expense of others is unavoidable.

What this means is that analysis of productivity change and income distribution will always reflect some interests over others. Analysis cannot be a dispassionate observer. The researcher will always flavor what is perceived.

I am not arguing that the Entitlement and Productivity framework is the definitive approach for studying productivity change and income distribution. No approach can be due to the normative nature of science. The Entitlement and Productivity framework is no less objective or scientific than others, but simply offers a different perspective on productivity change. It can be useful to those interested in seeing the role of the market context or in perceiving more policy options. The need to choose the perspective or interests reflected in the analysis, the other subjective choices required by the analyst, and the controversial nature of income and change guarantee that economic analysis of change will always be a subjective procedure.

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