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ESSAYS ON GLOBALIZATION, UNEMPLOYMENT, AND ECONOMIC GEOGRAPHY

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ABSTRACT

ESSAYS ON GLOBALIZATION, UNEMPLOYMENT, AND ECONOMIC GEOGRAPHY

By

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This dissertation presents three essays examining the role that falling trade costs and the resulting agglomerations have on unemployment. In addition, the role of regional (or national) labor market characteristics on agglomeration patterns is also examined.

The first essay extends the Krugman (1991) new geography model to include asymmetries in regional labor markets. The particular labor market considered is a two-region variant of the Shapiro-Stiglitz (1984) model where the rate of job breakup or shirker detection may vary between regions. It is shown that in the presence of such asymmetries agglomeration can occur even in the absence of transport costs. Furthermore, when transport costs are present it can be determined in which region agglomeration is most likely to occur. The essay also examines the spatial pattern of unemployment in both the symmetric and asymmetric cases.

The second essay presents a two-country, two-sector new geography model where workers are imperfectly monitored is used to examine the relationship between falling trade costs and unemployment. It is shown that as trade costs fall over time the world naturally falls into an industrialized core and an agricultural periphery. Globalization has a positive effect on employment in the core in both the short and long term. The periphery suffers employment losses in the short term but can gain in the long term. The

impact of labor market asymmetries on both the likelihood of agglomeration occurring in a specific country and unemployment is also examined.

The final essay extends the Krugman (1991) new geography model to include search frictions in the labor market. The particular labor market considered is a two-region variant of the Diamond (1982) model. It is shown that if the matching function exhibits constant returns to scale the pattern of agglomeration is identical to the full-employment model and there is no change in unemployment as a result of agglomeration. If the matching function exhibits increasing returns to scale agglomeration can be sustained no matter the level of trade costs and unemployment falls as a result of agglomeration. It is also shown that regions with higher rates of tenure will be more likely to receive an agglomeration.

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Chapter 1:

The Problem

How does globalization affect unemployment? This question is not new to any who have witnessed the political debates over the new global economy or the formation of free trade areas such as NAFTA in North America. To many economists the answer to this general question seems obvious: lower costs of trade mean an increase in the volume of trade which will benefit some sectors while harming others, but in the long term, after displaced workers have had time to retrain, there will be a net improvement in employment. However, given the ferocity of these debates in political circles one can conclude that not everyone has chosen to subscribe to this point of view. In particular, labor groups have raised their concerns of losing out to low wage competition from the less developed world. What is somewhat surprising is that a fairly small number of economists have researched directly the relationship between the falling costs of trade and their resulting effects on integration and employment. The results in the existing literature are mixed. Hanson (1998) shows that a fall in trade costs has a positive effect on unemployment in border towns in Mexico. However, he ignores any impact that falling trade costs may have in non-border towns. Milner and Wright (1998) show that, in theory, employment should expand in the exportables sector and contract in the importables sector in response to trade liberalization in a specific factor model of trade. But, empirically, the data used in their study show that employment has expanded in all sectors[1]. Brecher and Choudhri (1994) show that Pareto gains from trade and trade liberalization may be infeasible in the presence of unemployment. Revenga (1997)

[1] The data used in this study are confined to the country of Mauritius.

shows that trade reform in Mexico between 1985-88 has had a negative impact on manufacturing employment. Agenor and Aizeman (1996) show that when trade is liberalized and taxes are adjusted so that the government's budget does not change the resultant effect on employment is ambiguous. So, even in the limited literature that does exist on this subject there is no clear-cut conclusion among economists.

The goal of this thesis, then, is to examine the relationship between the falling costs of trade and unemployment at the national level. The models employed for this task draw on the *new geography* framework first proposed by Krugman (1991). This choice seems appropriate since changes in trade costs and the resulting effects on the economy can be modeled in a tractable manner. The basic story in the new geography literature is that the interaction between trade costs and scale economies will create incentives for firms to agglomerate production into a small number of locations. The intuition is straightforward. Firms will want to set up factories where demand is highest since that will minimize trade costs. However, demand will be highest in larger markets since a considerable share of demand comes from the manufacturing labor force. These forces are referred to as *backward linkages*[2]. These linkages will be reinforced by the fact that it will be more advantageous for a worker to reside in a larger market where trade costs apply to a smaller share of consumption goods. These forces are referred to as *forward linkages*[3]. Consequently, the reinforcing forward and backward linkages induce both

[2] Perhaps the term "supplier linkages" would be more appropriate since backward linkages refer to the reasons that suppliers would want to locate in a large market.
[3] Perhaps a better term here would be "demander linkages" since forward linkages refer to reasons why the demanders of manufactures would want to locate in a large market.

manufacturing firms and workers to locate into a small number of regions given that trade costs are sufficiently low[4].

In the story told above what drives the forward and backward linkages is that workers are free to move between regions. If the goal is to construct a trade model where labor is not internationally mobile then a slightly different approach is warranted. Furthermore, with immobile labor agglomeration, as it is defined above, cannot occur. So, again, a slightly different concept is necessary. The approach taken in this paper, attributed to Krugman and Venables (1995), is to use an intermediate good to play the role that mobile labor normally would in creating the forward and backward linkages. A country with a large manufacturing base provides firms locating there a greater variety of intermediates. This gives firms locating there lower costs of production, or a forward linkage[5]. A large base of final goods manufacturers also provides a large local market for intermediate goods producers, or a backward linkage. What results is not a concentration of people into a small number of locations but a concentration of manufacturing.

In both of the frameworks mentioned above a core-periphery pattern emerges. That is, a core base of regions (or countries) produce the bulk of the world's manufacturing goods and export these goods to the agricultural periphery. So, a natural divergence in production patterns emerge solely from falling transportation costs. This is a fundamental result in the new geography literature and has been used to explain the differences between the developed and the less developed countries of the world.

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[4] There have been numerous extensions of the basic Krugman (1991) framework. The most notable of these are Krugman and Venables (1995, 1996), and Venables (1996) extension to an open economy where instead of footloose labor firms are linked vertically. For a complete survey of the literature see Krugman (1998) and Fujita, et al. (1999).

[5] The linkages here may seem confused from the earlier story. However, here final goods producers are the demanders and intermediate goods producers are the suppliers.

In all three models presented in the following pages the new geography framework is merged with one of two types of unemployment. First, in Chapters 2 and 3 a variant of the efficiency-wage/worker-discipline model first proposed by Shapiro-Stiglitz (1984) is used. And second, a variant of the search framework developed by Diamond (1982) is used in Chapter 4. One benefit of using these particular forms of unemployment is that it allows one to examine the effects that labor market asymmetries have on the patterns of agglomeration. This is a subject that, to this point, has been absent from the new geography literature. In fact, most articles in this field assume that countries (or regions) are identical in every way except for the distribution of labor between industries. Given that such asymmetries do exist in the real world[6], incorporating these attributes into a new geography model seems relevant to the literature.

The model presented in Chapter 2 is a two-region model where manufacturing workers and firms are free to locate in either region. And, as mentioned above, unemployment arises through the imperfect monitoring of employed workers. If labor markets are symmetric it is shown that the pattern of agglomeration is identical to that of the Krugman (1991) model. However, if tenure is permitted to vary between regions the region with longer rate of tenure will be more likely to be the recipient of an agglomeration. In addition, it is shown that unemployment is decreasing in regional agglomeration.

The model presented in Chapter 3 uses a slightly different framework to analyze agglomeration patterns and unemployment between countries when labor is

[6] For instance, in the European Union rates of job tenure range from 4.4 years in Denmark to 10.7 years in Germany. See OECD (1998).

internationally immobile. Here, an intermediate good is used to play the role that mobile labor plays in a region model[7]. Again, unemployment in this model arises out of the imperfect monitoring of employed workers. The results are similar to those of Chapter 2. If labor markets are symmetric then labor dynamics are identical to those of Krugman and Venables (1995). However, if tenure is permitted to vary from country to country the country with longer rate of tenure will be more likely to be the recipient of an agglomeration of industry. In addition, it is shown that unemployment is decreasing in industry agglomeration. However, if trade costs fall to very low levels unemployment is lower for both countries compared to an equilibrium where neither country specializes in manufacturing goods.

The model presented in Chapter 4 returns to a two-region model where both firms and workers are free to locate in either region. Unemployment in this model arises from search frictions in the labor market. The results of this model depend on the homogeneity of the matching function. If the matching function exhibits constant returns to scale and labor markets are symmetric, again the labor dynamics mimic those of Krugman (1991). However, the unemployment rate is unchanged with changes in the labor distribution. Hence, there is no employment benefit to agglomeration. If, the matching function exhibits increasing returns to scale agglomeration can be sustained no matter the value of trade costs. And, unemployment is strictly decreasing in agglomeration. So, there is an employment benefit to agglomeration. Regardless of the homogeneity of the matching function, if tenure is permitted to vary between regions the region with longer rate of tenure will be more likely to be the recipient of an agglomeration.

[7] This framework was first presented in Krugman and Venables (1995).

There are a several general conclusions one can draw from these three models. First, when industry agglomerates unemployment will be at least as low as when industry does not agglomerate in "core", industrialized regions. So, one can conclude that, at least in this framework, globalization has at best a positive impact and at worst no impact on employment in developed nations. Second, in the short term unemployment will increase in peripheral, less developed nations, but in the long term unemployment rates will converge to those of the developed world. Third, labor market asymmetry has an influence on agglomeration patterns: agglomeration is more likely to occur in regions (or countries) where tenure is long relative to other regions. This reveals an oversight in much of the new geography literature that ignores individual regional characteristics which alter the results of models with symmetric regions.

Chapter 2:

A Two-Region Model with Imperfect Monitoring

I. Introduction

One theme that is common to most new geography models is that regions are assumed to be identical in every way except for population size. It is conceivable that regional asymmetries may encourage agglomeration economies even in the absence of trade costs. In particular, labor markets may not be identical in every location. Job tenure rates do vary significantly between regions. For instance, in the European Union (EU) rates of job tenure range from 4.4 years in Denmark to 10.7 years in Germany[1]. The bases of such differences can be attributed to cultural reasons as well as variations in public policy. No matter the source, these differences do exist in the real world.

This chapter, then, extends the Krugman (1991) framework to include asymmetries in regional labor markets. The particular model of unemployment used here is a variant of the efficiency-wage/worker-discipline model first proposed by Shapiro-Stiglitz (1984). In this setting, workers' incentive to shirk will provide an additional push (pull) towards (against) agglomeration. The region with the smaller incentive to shirk will tend to be more attractive since employment will be higher there. The incentive to shirk depends on both job tenure and the speed at which shirking workers are detected. The longer the job tenure and the shorter the time it takes to get caught shirking the smaller is the incentive to shirk and the more attractive the region.

Given the description above it is clear that labor dynamics will be somewhat altered from the Krugman (1991) model. Furthermore, the nature of the labor dynamics

[1] OECD, (1997)

are changed. In the efficiency wage model presented below employed workers are temporarily immobile. Hence, labor dynamics are completely determined by the location decision of unemployed workers. That is, in which region do unemployed workers choose to search for employment. If all regions are identical then the incentive to shirk is the same everywhere and labor dynamics are unchanged from the Krugman (1991) model. However, if regional labor markets vary it will be more likely that workers agglomerate into the region with the smaller incentive to shirk. That is, the regions where job tenure is highest and shirker detection is most rapid.

Since unemployment is included to examine labor market asymmetries the model is also equipped to determine the effects that changes in trade costs and agglomeration have on economywide unemployment. It is shown below that, regardless of symmetry, the lower are transportation costs the lower is unemployment. A more significant result is that, in the symmetric case, no matter the value of transportation costs the unemployment rate is decreasing in regional concentration. Hence, in a concentrated equilibrium unemployment is at its minimum and in a diversified equilibrium where workers are evenly distributed across regions unemployment is at its maximum. The asymmetric case is somewhat more complex. However, the major result still holds: as trade costs fall and the economy moves toward a concentrated equilibrium the unemployment rate declines.

Section II of this chapter describes the model. Section III describes the method used to simulate the model. Section IV determines the labor dynamics of the symmetric case and section V describes the labor dynamics of the asymmetric case. Section VI discusses the unemployment consequences of these labor dynamics. And, section VII offers some concluding remarks.

II. The Model

The model builds on the framework first developed by Dixit-Stiglitz (1977) and its extensions by Krugman (1979, 1980, 1991)[2]. Consider an economy in which there are two types of production: agriculture and manufactured goods; two factors of production: farm labor and manufacturing labor; and two regions. Farm labor is assumed to be perfectly immobile between regions[3], and manufacturing labor can locate in either region. The size of each type of labor force is normalized to one.

A. Agriculture

It is assumed that farm labor is evenly distributed throughout the economy with ½ located in each region. Agriculture is produced under constant returns to scale. The unit labor requirement is one and agriculture is taken as numeraire so that its price (and the wage of farm labor) is equal to unity. In addition, the simplifying assumption that agriculture can be transported between regions at no cost is made[4].

B. Preferences

All individuals share the utility function

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[2] Matusz (1994,1996,1998) presents a model of monopolistic competition with efficiency wages. However, geography is absent from his analysis.

[3] Since land is not included as a factor of production, this assumption is equivalent to assuming that farm labor is tied to the land.

[4] This is a crucial assumption. Including trade costs on the agricultural good in these types of models can alter the results of the model significantly. For more on this see Davis (1998), Fujita et al. (1999), and Rauch (1999).

(1) $$U = X_M^{\gamma} X_A^{1-\gamma} - e$$

where X_M is consumption of an aggregate of manufactured goods, X_A is consumption of agricultural goods, and e is workers' disutility of effort. It is assumed that e is positive for manufacturing workers who exert effort and zero for both shirking and farm workers. Hence, individuals will always spend a fraction γ of their incomes on manufactured goods and a fraction (1 - γ) of their incomes on agricultural goods. The manufactures aggregate is given by the CES subutility function

(2) $$X_M = \left[\sum_{i=1}^{n_1} (x_{i1})^{\frac{\sigma-1}{\sigma}} + \sum_{i=1}^{n_2} (x_{i2})^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}$$

where n_k is number of varieties produced in region k, x_{ik} is the consumption of variety i produced region k, and $\sigma > 1$ is the elasticity of substitution between varieties. Given equation (2), it is evident that individuals desire variety and will purchase some amount of each variety produced. The price index over manufactured goods for an individual residing in region k is given by

(3) $$\Pi_k = \left[n_k p_k^{1-\sigma} + n_j p_j^{1-\sigma} \tau^{1-\sigma} \right]^{\frac{1}{1-\sigma}}$$

where p_k is the price of a single variety produced in region k and $\tau > 1$ are iceberg trade costs; in order for one unit of the good to arrive at its destination τ units must be shipped. There are two notable characteristics of equation (3). First, the higher the fraction of products produced in region k the smaller is Π_k. Hence, when manufacturing is more concentrated in region k the price of manufactures as a whole is lower in region k, and consequently the price of manufactures as a whole is higher in the other region. Second, the higher are trade costs the higher is Π_k. So, manufacturing goods are more expensive when transport costs are large.

Solving the utility maximization problem and substituting demands back into (1), utility for a manufacturing worker in region k can be expressed in its indirect form as[5]

(4) $$U_k = \Gamma w_k \Pi_k^{-\gamma} - e$$

where $\Gamma = \gamma^{\gamma}(1-\gamma)^{1-\gamma}$.

C. Manufacturing Production

The production of each variety of manufactured goods (regardless of the region in which it is produced) requires both a fixed and a marginal input of manufacturing labor. In region k, let ℓ_{ik} be the amount of labor required to produce x_{ik} units of output. Then

(5) $$\ell_{ik} = \alpha + \beta x_{ik}$$

where $\alpha,\beta > 0$ are the fixed an marginal input requirements respectively. Since individuals desire variety via a CES sub-utility function with elasticity of substitution σ, each firm will behave as a monopolist of its own variety who faces a demand curve with constant elasticity of demand σ. So, to maximize profits each firm will set price so that the Lerner index is inversely proportional to σ. Noting that each firm's marginal cost is β times the wage of manufacturing workers in their respective locations, all firms in region k will then set price

(6) $$p_k = \left(\frac{\sigma}{\sigma-1}\right)\beta w_k$$

[5] Since agriculture is taken as numeraire the indirect utility of a farm worker in region k is given by replacing w_k with unity in equation (4). However, this measure is not essential for the analysis that follows.

In addition, new firms may freely enter the market and will do so until profits are driven to zero. A firm's average cost can be expressed as $[(\alpha + \beta x_{ik})w_k]/ x_{ik}$. In equilibrium, it must be the case that this expression is equal to the price charged by the firm. Equating this with equation (6) and solving for x_{ik} yields a scale of production that is independent of both the wage and the region in which production takes place

$$(7) \qquad x = \frac{\alpha}{\beta}(\sigma - 1)$$

So, all firms are of identical size regardless of the region in which they are located. Substituting equation (7) into equation (5), the amount of labor that each firm will hire is given by

$$(8) \qquad \bar{\ell} = \sigma\alpha$$

which is, again, identical for all firms regardless of their location. One implication of equations (7) and (8) is that if there is an increase in demand for manufactures the only way to meet this demand is for additional firms to enter the market and, consequently, for employment to rise.

D. The Manufacturing Labor Market

The market for manufacturing labor is a two region variant of the Shapiro-Stiglitz (1984) efficiency wage model. Workers in both regions receive disutility e from exerting effort. In addition, workers are imperfectly monitored by their employers. Hence, there is the possibility that a worker will shirk her responsibilities if she thinks that she can get away with it. In order to discourage such behavior workers receive a wage above the market clearing wage and any worker caught shirking is immediately dismissed by the firm. The threat of losing her job will prevent any worker from shirking in equilibrium.

Furthermore, in any steady state equilibrium there must be no incentive for an unemployed worker to relocate in hopes of greener pastures in the other region. Thus, unemployed workers must be indifferent to the region in which they are searching for employment. Let ρ be the exogenous discount rate which is assumed to be identical for all individuals regardless of their location. In region k, let q_k be the rate at which shirking workers are caught, and let b_k be the rate at which non-shirking workers lose their jobs. These exogenous parameters are permitted to vary between regions. In addition, let h_k be the endogenous rate at which workers are hired. Then, the asset value equations for a region k worker are

(9) $$\rho V_k^u = h_k\left(V_k^n - V_k^u\right)$$

(10) $$\rho V_k^n = \Gamma w_k \Pi_k^{-\gamma} - e + b_k(V_k^u - V_k^n)$$

(11) $$\rho V_k^s = \Gamma w_k \Pi_k^{-\gamma} + (b_k + q_k)(V_k^u - V_k^s)$$

where V_k^u is the expected lifetime utility of an unemployed worker in region k, V_k^n is the expected lifetime utility of a non-shirking worker in region k, and V_k^s is the expected lifetime utility of a shirking worker in region k. This assumes that an unemployed worker has no source of income.

First, the conditions under which workers have no incentive to shirk must be determined. A necessary and sufficient condition to guarantee this will be the case is $V_k^n \geq V_k^s$. Solving equations (9) – (11) and setting $V_k^n \geq V_k^s$ the no-shirking condition can be expressed

(12) $$\Gamma w_k \Pi_k^{-\gamma} \geq \frac{e}{q_k}\left[\rho + b_k + q_k + h_k\right]$$

Next, the location decision of an unemployed worker must be determined. An unemployed worker will choose to locate in the region in which she has higher expected lifetime utility. Hence, the location decision is determined by $\Lambda \equiv V_1^u / V_2^u$. If this variable exceeds unity unemployed workers will choose to locate in region 1 and if it less than unity unemployed workers will choose to locate in region 2. In solving equations (9) – (11) it can be shown that

$$(13) \qquad V_k^u = \frac{\left(\Gamma w_k \Pi_k^{-\gamma} - e\right) h_k}{\left(\rho + b_k + h_k\right)\rho}$$

In equilibrium, the no shirking condition, equation (17), is satisfied with equality. Combining this with equation (13)

$$(14) \qquad V_k^u = \frac{e}{\rho} \cdot \frac{h_k}{q_k}$$

Hence, the location variable can be expressed

$$(15) \qquad \Lambda = \frac{h_1}{h_2} \cdot \frac{q_2}{q_1}$$

To complete equation (15) an expression for h_k must be determined. In any steady state equilibrium the regional flow into employment must equal the regional flow out of employment. At any given point in time there are $\bar{\ell} n_k$ manufacturing workers employed in region k. The flow into employment in region k is then $h_k [L_k - \bar{\ell} n_k]$ where L_k is the number of manufacturing workers located in region k. The flow out of employment is the rate at which employed workers lose their jobs. This is given by $b_k \bar{\ell} n_k$. Equating these flows and solving for h_k gives

$$(16) \qquad h_k = \frac{b_k \bar{\ell} n_k}{L_k - \bar{\ell} n_k}$$

After some algebra and noting that the unemployment rate in region k is given by

$\mu_k \equiv \mu(L_k, n_k) = 1 - \bar{\ell} n_k / L_k$, the job acquisition rate can be expressed

$$(17) \qquad h_k = b_k \left[\frac{1-\mu_k}{\mu_k} \right] = b_k \eta(\mu_k)$$

Note that the job acquisition rate is decreasing in the unemployment rate. Now the location variable can be written

$$(18) \qquad \Lambda = \frac{q_2}{q_1} \cdot \frac{b_1}{b_2} \cdot \frac{\eta(\mu_1)}{\eta(\mu_2)}$$

Equation (18) completely determines the regional labor dynamics of the model. In the Krugman (1991) model there are three effects determining labor dynamics which manifest themselves into the real wage. First, the home market effect: the wage will tend to be higher in the larger market since firms in the smaller market must have a labor cost advantage to combat their disadvantage in higher transport costs[6]. Second, the price index effect: workers in the larger market will face lower prices since they pay transport costs on a smaller proportion of their consumption goods. And third, the extent of competition: competition in the larger region may become so fierce that it is beneficial to locate near farm labor in the smaller region. These effects may appear to be absent from equation (18), however, here they have manifest themselves into the unemployment rate. The first two will tend to lower unemployment in the larger region while the latter will tend to lower unemployment in the smaller region. But in the present analysis there is a fourth force at work, a *shirking effect* which drives workers into the region where there is a smaller incentive to shirk. So, although labor dynamics are slightly altered from the

[6] For a complete discussion of this see Krugman (1980).

full-employment model all of the determinants of these dynamics are present in the current model.

E. Regional Income and Demand

To complete the model regional incomes and demands for each individual variety must be determined. The total income of persons located in region k is given by

(19) $$Y_k = .5 + w_k n_k \bar{\ell}$$

where the first term is income of farm labor and the second term is the income of manufacturing labor. Since preferences are Cobb-Douglass, region k expenditure on manufactures is given by

(20) $$E_k = \gamma Y_k$$

Then, demand for manufactures in region k can be expressed

(21) $$x_k = p_k^{-\sigma}\left[E_k \Pi_k^{\sigma-1} + E_j \Pi_j^{\sigma-1} \tau^{1-\sigma}\right]$$

where the first term inside the brackets represents local demand and the second term represents non-local demand. Note that if incomes were the same in both regions a region k firm would see a larger proportion of its demand coming from local consumers than from non-local consumers since locals need not pay the costs of transport on locally produced goods. Hence, demand will favor local products. Equilibrium is now characterized by equations (3), (6), (12), (18), (19), (20), and (21) which can be used to solve for the equilibrium values of p_k, w_k, Π_k, n_k, Y_k, E_k, and L_1.

III. Model Simulation

Solving the model analytically proves to be an intractable problem. However, it is straightforward to use numerical simulation techniques to examine the characteristics of the equilibrium given particular values of the model's underlying parameters.

A. Methodology

The following describes the procedure used to simulate the model. Substituting equation (6) into equation (3) and choosing units of measurement so that $\left(\frac{\sigma}{\sigma-1}\right)\beta = 1$, the price index over varieties for individuals residing in region k can be expressed as

$$(22) \qquad \tilde{\Pi}_k = \left[n_k w_k^{1-\sigma} + n_j w_j^{1-\sigma}\tau^{1-\sigma}\right]^{\frac{1}{1-\sigma}}$$

Substituting this and equation (16) into equation (12) yields the two no-shirking conditions as functions of n_k and w_k given L_1. Then, substituting equation (19) into equation (20) and substituting this result along with equation (22) into equation (21) gives two demand equations as functions of n_k and w_k given L_1. Hence, there are four equations in the four unknowns n_k and w_k given the distribution of labor between regions. These solutions can then be substituted into equation (18) to trace out Λ as a function of L_1. From this point forward this function will be referred to as the labor dynamics (LD) curve.

B. Parameterization

The values of the parameters that appear in both the full-employment model and the current model (i.e. γ and σ) are identical to those used in Krugman (1991). Therefore, any results obtained here that differ from those of Krugman can be attributed solely to the addition of efficiency wages to the manufacturing labor market. Table 2-1 lists the values of the parameters used in the simulation that are the same in both regions.

Table 2-1: Simulation Parameters

γ	σ	ρ	e	b	q	α
.30	4	.04	.385	.13	.5	7.413×10^{-8}

The expenditure share of manufactures is .30. Hence, individuals spend 30% of their incomes on differentiated goods and 70% on agriculture. The elasticity of demand is equal to 4, which corresponds to a markup of price over marginal cost of roughly 33%. The choice of $\rho = .04$ is roughly consistent with recent real rates of interest in the EU 15 according to OECD (1996). The choice of e implies the aggregate rate of unemployment will fall somewhere between 9.8% and 10.6%. Again, this is consistent with recent EU 15 figures. Finally, the value of α determines firm size which will, in turn, play a role in determining the number of varieties produced in each region. Given the normalization of the labor force the choice of $\alpha = 7.413 \times 10^{-8} = (2.9652 \times 10^{-7})/\sigma$ is equivalent to a firm size of 50[7].

[7] The last term of the expression for α is to assure that firm size does not change when the elasticity of demand changes. This makes the present model easier to compare with a full-employment version where firm size can be eliminated from the analysis.

IV. Labor Dynamics with Symmetric Regions

When labor markets are symmetric $b_k = b$ and $q_k = q$ for $k = 1,2$. Thus, the location variable is given by

$$(23) \qquad \Lambda = \frac{\eta(\mu_1)}{\eta(\mu_2)}$$

Since all of the efficiency wage parameters affect each region in exactly the same way there is an equal incentive to shirk in both regions. So, it is as if the shirking effect is absent. As a result, the same forces that determine labor dynamics in the full-employment model will determine labor dynamics in the current model.

Although b and q are absent from the location decision variable, they do appear in the no-shirking condition. So, values for these parameters must be assigned. Since jobs arrive according to a Poisson process, 1/b is the average job tenure in the manufacturing sector. Setting b = .13 implies the average job lasts roughly 7.7 years. This is approximately the average tenure in the EU 15[8]. Similarly, 1/q is the amount of time it takes for a shirking worker to get caught. Setting q = .5 implies it takes two periods for this to occur. It is not clear whether this is an appropriate value to use here; however, the dynamics of the model are insensitive to changes in q.

A discussion of the dynamics of the model when there are no trade costs (i.e. τ = 1) is useful here. When there are no trade costs both the manufacturing wage and the price of manufactures are the same in both regions. Otherwise, the product market will not clear. Since the efficiency wage parameters affect all workers in exactly the same manner the unemployment rate will be identical in both regions regardless of each

[8] This number is a weighted average of median tenure rates in the EU 15 according to OECD (1997) where the weights are each country's proportion of total EU 15 population.

region's size. Given the definition of the location variable in equation (23) there is nothing to encourage or discourage the population to deviate from its initial distribution. So, when there are no trade costs location doesn't matter and the LD curve is horizontal at $\Lambda = 1$.

Figure 2-1: Labor Dynamics with Symmetric Regions

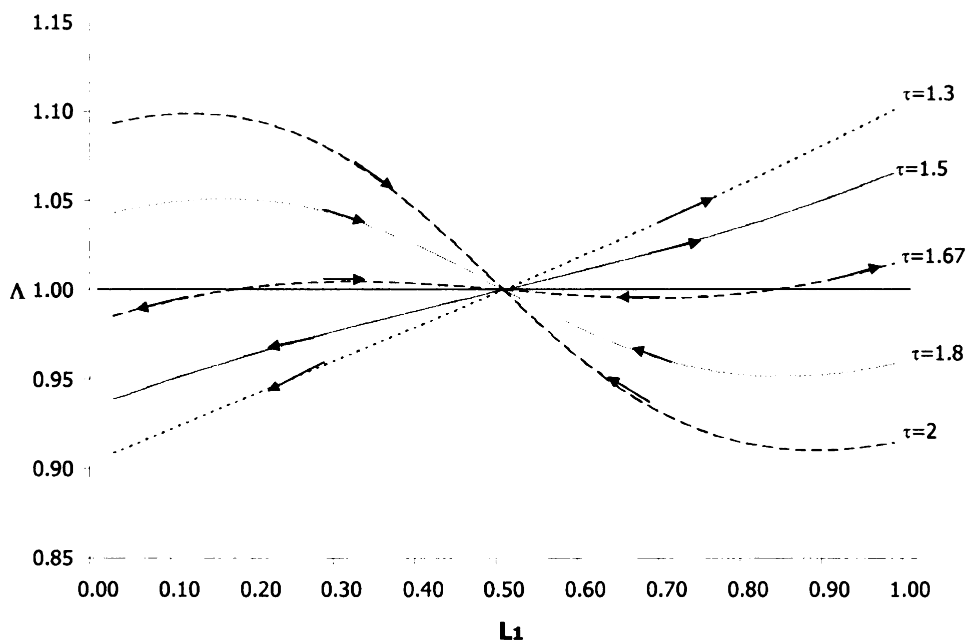

Figure 2- 1 depicts the LD curve for several different values of trade costs. When trade costs are high the LD curve is downward sloping suggesting that the extent of competition dominates the price index and home market effects. Here an even distribution of labor is the only equilibrium. Then, as trade costs fall the LD curve begins to flatten out until, at an intermediate level, there are multiple equilibria. For some labor distributions the price index and home market effects are dominated by the extent of competition and for others the reverse is true. So, the current distribution of labor will

determine whether agglomeration occurs or not. Finally, as trade costs fall further the extent of competition finally succumbs to the price index and home markets effects for all distributions of labor and agglomeration is the only stable equilibrium[9]. The region in which agglomeration occurs is determined entirely by the initial distribution of labor[10].

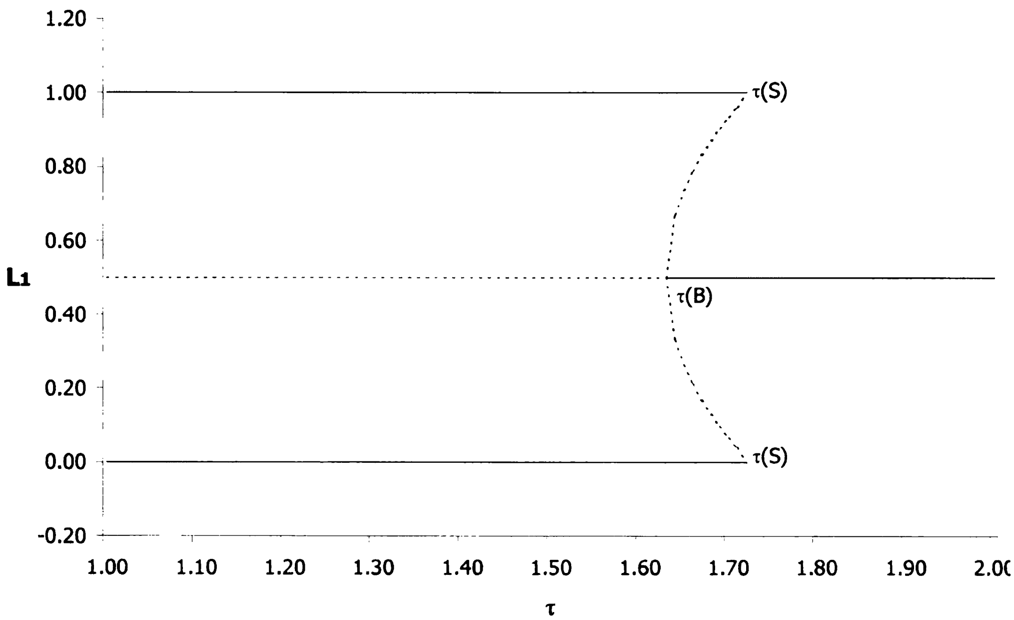

Figure 2-2: Bifurcation Diagram with Symmetric Regions

To fully understand the structure of equilibria it is useful to look at the bifurcation diagram shown in Figure 2-2. The solid lines represent stable equilibria and the dashed lines represent unstable equilibria. When trade costs are high the symmetric equilibrium is the only equilibrium that can be sustained. Then, when transport costs fall they reach a

[9] A symmetric distribution of labor is an equilibrium. However, it is unstable. Any deviation from this equilibrium will shoot the economy to an agglomerated equilibrium.
[10] Note that if trade costs continue to fall the LD curve will eventually flatten out once again. For a detailed explanation see Fujita et al. (1999).

threshold below which a concentrated equilibrium can be sustained in addition to the symmetric equilibrium. Adhering to the terminology in Fujita et. al. (1999), this is called the sustain point and is labeled $\tau(S)$ in Figure 2-2. As trade costs fall further a second threshold is reached below which the symmetric equilibrium breaks down and concentration is the only sustainable equilibrium. This is called the break point and is labeled $\tau(B)$ in Figure 2-2. Table 2-2 lists the break and sustain points for several values of σ and γ.

Table 2-2: Break and Sustain Points for Various Parameter Values

	$\gamma = .3$		$\gamma = .5$		$\gamma = .7$	
	τ(B)	**τ(S)**	**τ(B)**	**τ(S)**	**τ(B)**	**τ(S)**
$\sigma = 4$	1.63	1.718	2.455	3.761	5.858	94.68
$\sigma = 6$	1.317	1.348	1.646	1.96	2.303	7.42
$\sigma = 8$	1.21	1.229	1.41	1.569	1.759	3.412

The results thus far are identical to those of Krugman (1991). In fact, it is straightforward to determine break and sustain points in full-employment model for the same values of σ and γ as in Table 2-2. When this is done the break and sustain points are identical in both models. This should be expected since exactly the same forces determine labor dynamics in both models.

V. Labor Dynamics with Non-Symmetric Regions

The analysis now turns to the case where either the rate of job breakup or the rate of shirker detection differs between regions. Why might these parameters be different in regions that are otherwise identical? First, as Shapiro-Stiglitz (1984) notes, the breakup rate is ultimately linked to the employment package offered by firms. In the model presented here the package includes only the wage. However, in the real world this may include any number of benefits such as health insurance, vacation time, and so on, which are absent from the present analysis. Suppose that these services are simply available for employees to use at no additional labor cost. Then, it is plausible that the level of these services will differ between regions based on history. Furthermore, reactions of the public sector to unemployment may also differ from location to location especially if local governments are permitted to determine their own policy[11]. Second, the rate of shirker detection may differ by similar reasoning. Cultural reasons may determine the level of detection that firms in a particular region settle on. In some areas workers may appear to their employers as more dependable and honest than workers in other regions. Or, employers may be more trusting in some regions than in others. For these reasons, it is conceivable firms in one region will settle at a different level of detection than the firms in another region.

A. Differences in the Rate of Job Breakup

Suppose that the rate at which non-shirking workers lose their jobs is not identical in both regions. The location variable is then given by

[11] This is certainly the case in the EU where each country decides its own public policy as well as in the US where policies are often vary from state to state.

(24) $\Lambda = \frac{b_1}{b_2} \cdot \frac{\eta(\mu_1)}{\eta(\mu_2)}$

Unlike the symmetric case, in the absence of transportation costs location does matter. This is due entirely to the shirking effect which, unlike the other forces driving labor dynamics, does not depend on transportation costs. There will be a larger incentive to shirk in the region with the higher breakup rate. In the absence of transportation costs the wage will be the same in both regions. Otherwise, the product market will not clear[12]. So, in order to satisfy the no shirking condition it must be the case that employment is higher in the low breakup rate region. Furthermore, it must be the case that $b_k \eta(\mu_k)$ is largest in the low breakup rate region[13]. Hence, it will always be more attractive to search in the region with the smaller value of b_k.

When transportation costs are incurred (i.e. $\tau > 1$) there will then be four effects at work: the home market effect, the price index effect, the extent of competition, and the shirking effect. However, the shirking effect will not work in a symmetric fashion as the others do. It will work in favor of concentration into the low breakup rate region and against concentration in the high breakup rate region. Again it is easiest to analyze the model with the use of numerical simulations. It is assumed that the breakup rate is smaller in region one. The diagrams that follow were generated with $b_1 = .12$, $b_2 = .15$, and all other parameters as listed in Table 2-1. Figure 2-3 depicts the labor dynamics curve for various levels of trade costs. The first characteristic to note about this diagram is that it has the same basic form as Figure 2-1. However, there is one noteworthy

[12] This is a direct result of the CES demand structure. If the price of manufactures (and thus the wage) is higher in one region than the other then demand for a single variety in that region will be smaller than in the other region. However, the price that clears the market must be the same in both locations since all firms have identical scale. Inspection of equation (21) will confirm this.

[13] This can be confirmed by substituting equation (17) into equation (12) and setting $w_1 = w_2$.

difference: the curves are no longer symmetric around $L_1 = .5$. In fact, all symmetry is now lost.

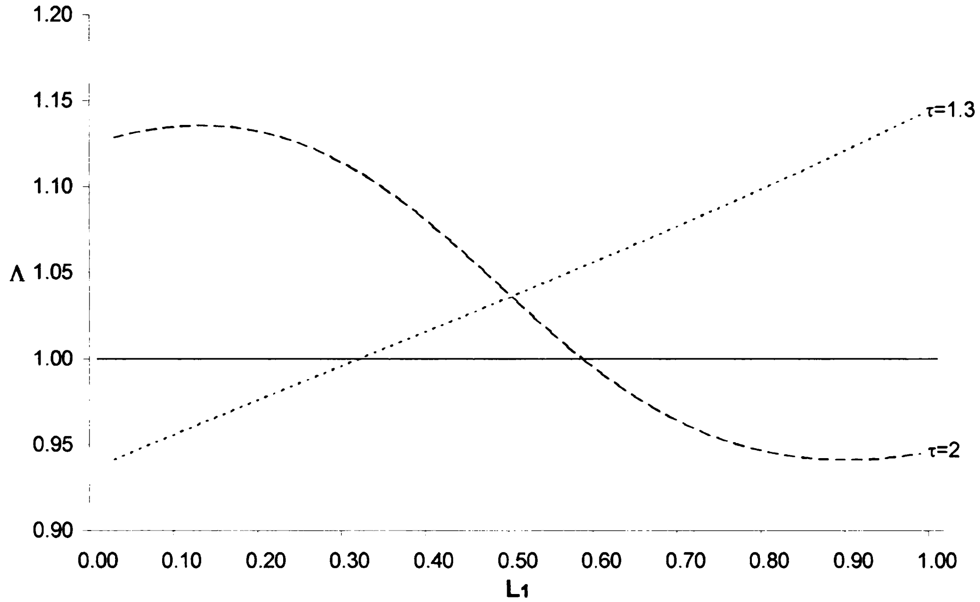

Figure 2-3: Labor Dynamics with Asymmetric Regions

Consider the high transport cost case, $\tau = 2$. In this case, as in the symmetric model, there is only one stable equilibrium. However, the equilibrium lies at a labor distribution that is skewed in the direction of region 1, where the breakup rate is lower. Here, the home market and price index effects as well as the extent of competition work in exactly the same way as in the symmetric model pulling the economy towards a diversified equilibrium. However, the shirking effect is now pushing concentration into region 1. So, it is not surprising that the stable equilibrium is skewed in this direction. Now consider the low transport cost case, $\tau = 1.3$. Here, as in the symmetric case, there are two stable equilibria: concentration in either region. But now the unstable equilibrium is skewed in the direction of region 2. Again, this result should be expected. With a low level of transport costs the extent of competition is weak which pushes the stable equilibria to the endpoints. Since the shirking effect is drawing workers into region 1 this skewness simply suggests that it more likely that the population agglomerates into region 1 rather than region 2, given a random initial distribution of labor.

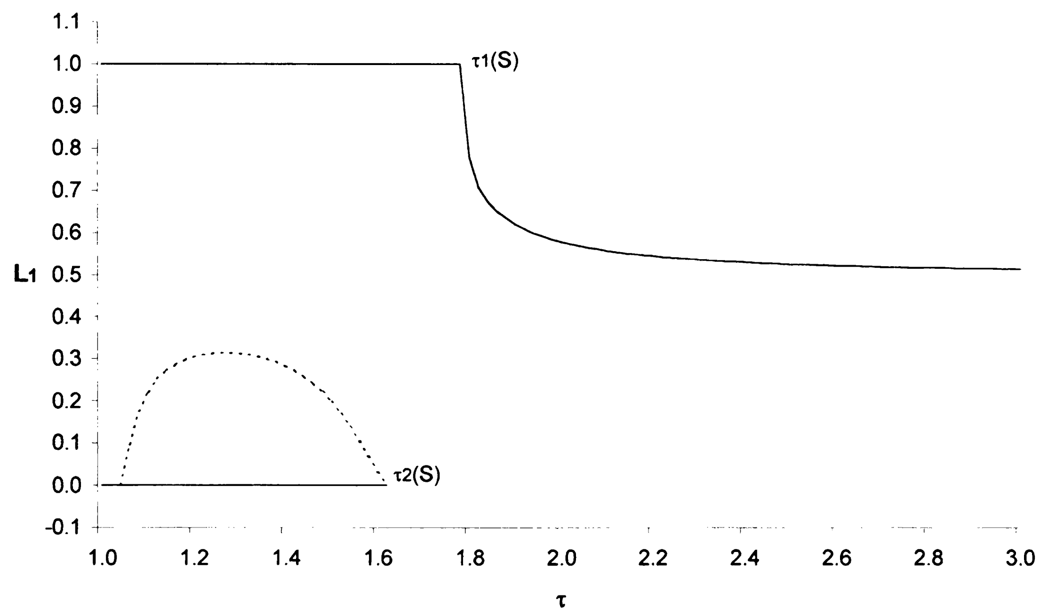

Figure 2-4: Bifurcation Diagram with Asymmetric Regions

Figure 2-4 shows the bifurcation diagram for the non-symmetric case. As transportation costs fall, the LD curve begins to flatten out pushing the stable equilibrium further and further towards concentration into region 1. This is a sensible result since as transport costs fall the need to locate near final demand weakens and concentration becomes more likely. Then, when transport costs fall further to the region one sustain point, $\tau_1(S)$, concentration in region 1 is the only solution. As transport costs fall even further to the region 2 sustain point, $\tau_2(S)$, the LD curve becomes upward sloping and concentration in either region can be sustained.

It is important to note that in a world of falling transport costs the equilibrium that the economy will tend to is with all manufacturing located in region 1. The only way agglomeration in region 2 could be sustained is if trade costs were initially below the region 2 sustain point and the population was sufficiently skewed towards region 2. While the latter of these is certainly not out of the realm of possibilities, the former is.

B. Differences in the Rate of Shirker Detection

Now attention turns to the case where the rate of shirker detection is permitted to vary between regions. In this case, the location variable can be expressed

$$(25) \qquad \Lambda = \frac{q_2}{q_1} \cdot \frac{\tilde{\mu}_1}{\tilde{\mu}_2}$$

Again, in the absence of trade costs location does matter. There is a shirking effect at work here just as when the breakup rate is non-symmetric. There will be a smaller incentive to shirk in the region with the higher rate of shirker detection. Hence, employment will tend to be higher in that region. So, with no trade costs, it is always more beneficial to search in the region with the higher rate of shirker detection. When transportation costs are incurred the shirking effect will draw workers into the region with the higher detection rate causing similar asymmetries as those in the previous sub-section. In fact, the diagrams one can derive in this case are similar to Figures 2-3 and 2-4. In addition, the intuition behind the shapes of these diagrams is identical. The only difference is the source of the shirking effect: in this case it comes from a higher rate of shirker detection and in the previous case it comes from a lower rate of job breakup. In light of this, a formal discussion will be suppressed.

V. Unemployment

How will the equilibrium behavior discussed above affect the economy's unemployment rate? The economy's unemployment rate is given by

(26) $$\mu_A = 1 - \bar{\ell}(n_1 + n_2)$$

The answer to the question posed above depends on whether n_k increases or decreases with a change in the distribution of labor. This, in turn, depends on whether the shirking effect is present or absent. The unemployment dynamics of the model, then, differ between the symmetric and asymmetric cases.

A. Unemployment with Symmetric Labor Markets

Figure 2-5 depicts the aggregate unemployment rate as a function of the proportion of workers located in region 1 for both high and low trade costs when labor markets are symmetric. There are two important features of this diagram. First, the unemployment rate is always lower when trade costs are lower. Looking at the derivative of the aggregate unemployment rate with respect to trade costs when the economy is not agglomerated[14]

(27) $$\left.\frac{d\mu_A}{d\tau}\right|_{0 \le L_1 \le 1} = -\bar{\ell}\left[\frac{dn_1}{d\tau} + \frac{dn_2}{d\tau}\right] > 0$$

The positive sign follows from the price index effect mentioned above. If transportation costs increase then demand for manufactures must decrease everywhere since manufacturing goods are now more expensive. So, lower transportation costs will always result in lower rates of unemployment.

[14] Although explicit expression cannot be obtained for the derivatives discussed in this section their signs (and sometimes their relative magnitudes) can be determined through a little intuition.

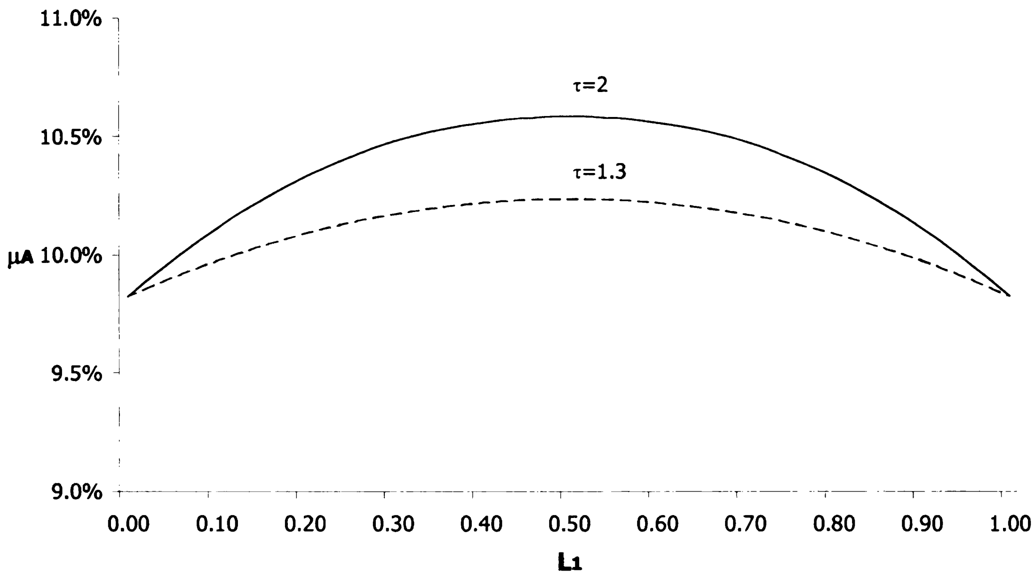

Figure 2-5: Unemployment with Symmetric Regions

Second, a regionally concentrated equilibrium minimizes the unemployment rate and an even distribution of labor maximizes the unemployment rate. Suppose that the distribution of labor in the economy is currently where $L_1 = 0$, i.e. complete concentration into region 2. At this point, the derivative of unemployment with respect to labor entering region 1 is given by

$$(28) \qquad \left.\frac{d\mu_A}{dL_1}\right|_{L_1=0} = -\bar{\ell}\frac{dn_2}{dL_1} > 0$$

Any deviation away from an agglomerated equilibrium will cause manufactures to be more expensive for everyone in the economy. This will cause the demand for region 2 varieties to decline. Hence, the sign of this derivative is positive. Now consider the case where $0 < L_1 < .5$. Now the derivative can be expressed

$$(29) \qquad \left.\frac{d\mu_A}{dL_1}\right| = -\bar{\ell}\left[\frac{dn_1}{dL_1} + \frac{dn_2}{dL_1}\right]$$

There are two forces influencing the signs of the two terms inside the brackets. First, a shift in population into region 1 makes manufactures less expensive for region 1 residents which tends to make both terms positive. Second, the shift in population makes manufactures more expensive for region 2 residents which tends to make both terms negative. Demand will always favor local products because individuals do not have to pay transportation costs on locally produced goods. Hence, local effects will dominate non-local effects. The first term is, then, positive and the second term is negative. The magnitudes of these effects will depend on the size of the region. Since region 2 is the larger region it follows that the second term dominates the first and the net sign of the derivative is positive. Now suppose that the distribution of labor is such that $.5 \leq L_1 < 1$. In this case the two terms inside the brackets have the same signs as before. But now region 1 is the larger region so the first term dominates the second and the sign of the derivative in equation (29) is negative. All of this together would imply the shape of the curve given in Figure 2-5.

B. Unemployment with Non-Symmetric Labor Markets

The spatial pattern of unemployment changes drastically when asymmetries in the labor market are introduced. Figure 2-6 shows the labor distribution/unemployment curve for the non-symmetric case.

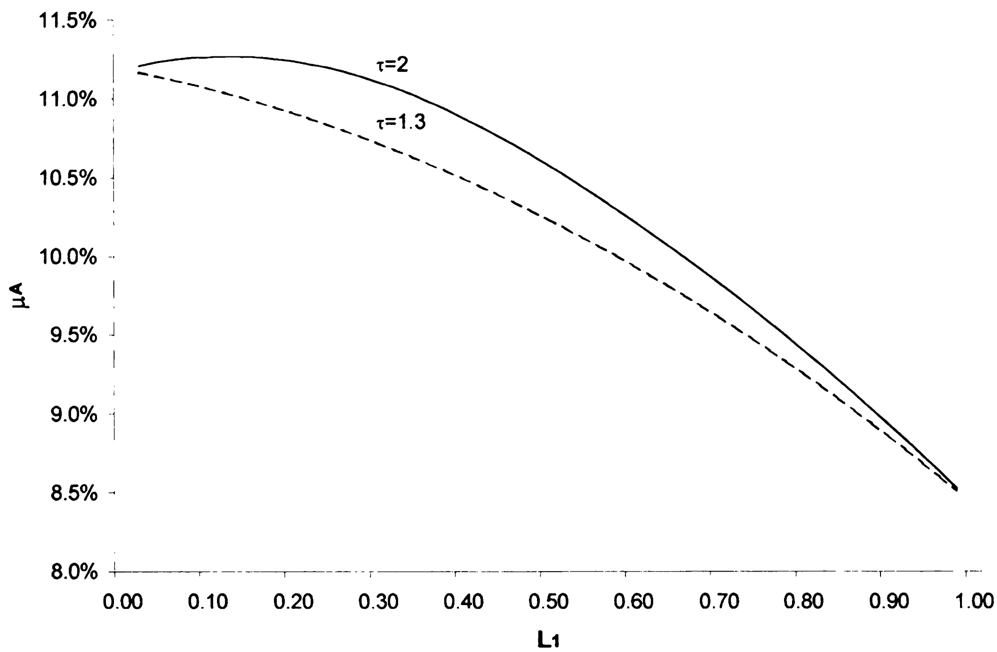

Figure 2-6: Unemployment with Asymmetric Regions

This diagram only shares one feature with Figure 2-5: when transport costs fall the unemployment rate is lower. This can be explained in exactly the same manner as in the symmetric model: when transportation costs fall manufactures are now less expensive for everyone in the economy so demand will rise in both regions, thus, reducing unemployment. However, the spatial variation in unemployment is now very different. There are two notable disparities from the symmetric case. First, concentration into region 1, where the breakup rate is lower, results in a lower rate of unemployment than concentration into region 2. This is due to the shirking effect. A lower rate of job breakup will result in a smaller incentive to shirk and higher employment. Second, if transportation costs are high there is an upward sloping portion to this curve, and if transport costs are low enough the curve is strictly downward sloping. Again, it is useful to use some intuition on the signs of some derivatives. Suppose that the economy is concentrated in region 2. i.e. $L_1 = 0$. Then, the derivative of economywide unemployment with respect to workers entering region 1 is again as given in equation (28). However, the intuition concerning the sign is a little different. There are two effects at work when workers migrate into region 1. First, the number of varieties produced in region 2 should fall since manufacturing products have become more expensive as a whole. This will tend to increase the unemployment rate. Second, since the incentive to shirk is lower in region 1 a higher proportion of the defecting workers will be employed than if they remained in region 2. This will tend to decrease the unemployment rate. Which of these dominate depends on the level of transportation costs. If transportation costs are high the first effect will dominate and the unemployment rate will to rise slightly. However, if transport costs are low the price index effect will be weak and the unemployment rate will fall. If L_1 is between 0 and 1 then the derivative with respect to workers entering region 1 is as given in equation (29). The signs of the two terms in brackets are the same as in the symmetric case. However, which term dominates not only depends on region size but also on transport costs and the shirking effect. If transport costs are very high and the region with the smaller incentive to shirk is small then the larger region will dominate. In this situation the price index effect will be particularly strong and local demand bias will be very high which will undermine the shirking effect. However, when the smaller region reaches a critical size the shirking effect will take over and unemployment will fall as residents enter the region with the smaller incentive to shirk. With a lower level of transport costs local demand bias will be weak and the smaller incentive to shirk will dominate for all possible labor distributions. These imply the shapes of the curves in Figure 2-6.

VI. Conclusion

The analysis above uses a new geography model that includes unemployment in the form of an efficiency wage to show that that the presence of labor market asymmetries is an additional source of agglomeration that has not yet been considered in the literature. When the values of the efficiency wage parameters are not identical in all regions the model can predict in which region manufacturing is most likely to locate. Unless trade costs are very low initially, which is highly unlikely, manufacturing production will always gravitate to the region with the lower rate of job breakup, or the higher rate of shirker detection.

The model also determines the effects of agglomeration on unemployment in both the symmetric and asymmetric cases. As trade costs fall and labor begins to gravitate into a single region, the unemployment rate declines. Furthermore, if the economy reaches complete agglomeration the unemployment rate will tend to its minimum regardless of the symmetry (or asymmetry) of the model. This highlights an additional benefit to an economy that agglomerates. Not only will incomes be higher as shown by Krugman (1991), but employment will also rise.

Chapter 3:

A Two-Country Model with Imperfect Monitoring

I. Introduction

The goal of this chapter's model is to examine the relationship between the falling costs of trade and unemployment at the national level in different countries. The approach taken in this paper, attributed to Krugman and Venables (1995), is to use an intermediate good to play the role that mobile labor played in the model of Chapter 2 in creating the forward and backward linkages. The model builds on this framework to include a form of the efficiency-wage/worker-discipline model first proposed by Shapiro-Stiglitz (1984)[1] and used in Chapter 2. Quite surprisingly, this particular form of unemployment provides an additional force encouraging manufacturing to concentrate into a small number of countries due to the effects that agglomeration has on employment. As a result, the labor dynamics are altered in such a way that the agglomeration of manufactures is more likely to occur in a world with efficiency wages than in a full-employment environment! The model also shows that lower trade costs cause unemployment to fall in all countries if agglomeration economies fail to arise. However, in the event that agglomeration does take place countries where agglomeration arises reap large employment gains and countries that are the victim of a manufacturing exodus suffer large employment losses in the short term. Which countries gain and which countries lose is completely determined by industrial history. That is, which countries historically have produced a large amount of manufactures and which have not. In the long term, however, all countries can enjoy employment gains from globalization if trade costs fall far enough.

[1] For other mergings of monopolistic competition and the worker discipline model see Matusz (1996,1998).

The model also examines the case where labor markets are not identical across countries. In particular, the situation where rates of job tenure differ between countries is taken up. In such an asymmetric world the model shows that countries with higher tenure rates are more likely to be the recipients of an agglomeration of industry. The higher rates of tenure lead to a fall in the rate of unemployment that will deter workers from shirking. This will attract manufacturing making it more likely that industry agglomerates there. So, although industrial history is still a driving force, differences in national labor markets can have an impact on the pattern of agglomeration.

Section II describes the model. Section III describes the simulation techniques used to obtain the model's conclusions. Section IV examines the simulation results for a symmetric world. Section V examines the simulation results in an asymmetric world. And section VI provides some concluding remarks and directions for future research.

II. The Model

Consider a world in which there are two countries; one factor of production: labor; and two goods: agriculture and manufactures. Labor is permitted to move between sectors but not across international borders. The size of each country's labor force is normalized to one.

A. Agriculture

Agriculture is produced in a perfectly competitive environment. However, workers in this sector, as well as the manufacturing sector, face the possibility of unemployment[2]. The unit labor requirement is one and agriculture is taken as numeraire so that both the

[2] The labor market will be described in detail below.

price of agriculture and the wage paid to farmers is equal to unity. For simplicity it is assumed that agriculture can be traded at no cost[3].

B. Preferences

All individuals in the economy share the utility function

(1) $$U = X_A^{\gamma} X_M^{1-\gamma} - e$$

for $0 < \gamma < 1$, where X_A is consumption of agriculture, X_M is consumption of an aggregate of manufactured goods, and $e > 0$ is workers disutility of effort. Hence, consumers will always spend γ of their income on agriculture and $1 - \gamma$ of their income on manufactures. The manufactures aggregate is given by the CES subutility function

(2) $$X_M = \left[\sum_{i=1}^{n_1} (x_{i1})^{\frac{\sigma-1}{\sigma}} + \sum_{i=1}^{n_2} (x_{i2})^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}$$

where n_k is the number of manufacturing varieties produced in country k, and $\sigma > 1$ is the elasticity of substitution between varieties. Hence, the model incorporates the *love-of-variety approach*[4]. The price index over manufactures in country k can then be expressed

(3) $$\Pi_k = \left[n_k {P_k^M}^{1-\sigma} + n_j \left(P_j^M \tau\right)^{1-\sigma} \right]^{\frac{1}{1-\sigma}}$$

where P_k^M is the price of a single variety of the manufacturing good in country k, and τ is the iceberg trade cost of shipping a unit of manufactures from one country to the other. That is, in order for one unit of the good to arrive at its destination τ units must be shipped. There are two noteworthy characteristics of equation (3). First, the higher the

[3] Including trade costs on the agricultural good in these types of models can shrink the range of parameters for which agglomeration can be sustained. However, it will not change the results presented here. For more on this see Davis (1998), Fujita et al. (1999), and Rauch (1999).

[4] See Dixit-Stiglitz (1977) and Krugman (1979, 1980).

fraction of products produced in country k the smaller is Π_k. Hence, if manufacturing is more concentrated in country k than country j the price of manufactures is lower in country k than in country j since consumers need not pay trade costs on a larger proportion of the total manufactures produced. Second, the larger is τ the larger is Π_k. So, manufacturing goods are more expensive when transport costs are large. After solving the utility maximization problem a sector r worker's indirect utility in country k can be written

$$(4) \qquad U_k^r = \Gamma w_k^r \Pi_k^{-\gamma} - e$$

for $r = \{A,M\}$ where $\Gamma = \gamma^{\gamma}(1-\gamma)^{1-\gamma}$.

C. Manufacturing Production

Manufacturing production in country k requires the use of a composite input that is a Cobb-Douglas combination of labor and intermediate goods. For simplicity it is assumed that the price index over intermediate goods is identical to that of final manufactures. Hence, the price index of both intermediate goods and final goods is given by equation (3)[5]. The production function for the composite input in country k can be expressed

$$(5) \qquad C_k = \Theta \ell_k^{\theta} X_M^{1-\theta}$$

where $\Theta = \theta^{-\theta}(1-\theta)^{\theta-1}$. After solving the cost minimization problem the unit cost for the composite input in country k can be expressed

$$(6) \qquad P_k^C = w_k^{\theta} \Pi_k^{1-\theta}$$

[5] This is a simplification proposed by Krugman and Venables (1995) making it possible to include intermediates in production without explicitly modeling the intermediates sector. Using this approach, intermediate goods and final goods are the same good, X_M.

Production for the final good, then, requires a fixed and a marginal input of this composite good. The amount of the composite good required for firm i in country k to produce x_{ik} units of the final good can be written

$$(7) \qquad C_{ik} = \alpha + \beta x_{ik}$$

where α and β are the fixed and marginal inputs respectively. So, the total cost of producing x_{ik} units of the final good can be expressed

$$(8) \qquad TC_{ik} = C_{ik}P_k^C = (\alpha + \beta x_{ik})P_k^C$$

In this monopolistically competitive environment each firm will view itself as a monopolist facing a demand curve with elasticity σ. So, each firm will set price $\sigma/(\sigma - 1)$ over marginal cost. Choosing units of measurement for the composite good such that $\beta = (\sigma - 1)/\sigma$ all firms in country k will set price for the final manufacturing good

$$(9) \qquad P_k^M = w_k^\theta \Pi_k^{1-\theta}$$

So, the price of the final good is identical to that of the composite good. In equilibrium price must equal average cost. Setting equation (9) equal to average cost and solving for the firm's scale of production yields

$$(10) \qquad x = \alpha\sigma$$

Hence, all firms produce an identical scale of output that is independent of both input prices and location. Given the production function and that firms earn zero profits in equilibrium, it is evident that firms will devote a fraction θ of their total revenue to the wage bill. Hence,

$$(11) \qquad \theta P_k^M n_k x = w_k^M n_k \ell_k$$

where ℓ_k is the number of workers hired by a manufacturing firm located in country k. Choosing units of measurement for the final good so that x = 1/θ, this can be solved for ℓ_k to get

$$(12) \qquad \ell_k = \frac{P_k^M}{w_k} = \left(\frac{\Pi_k}{w_k}\right)^{1-\theta}$$

While the scale of output is independent of location, the number of workers hired by firms is not. A low cost for labor or a large cost for intermediates will tend to increase the amount of labor and decrease the quantity of intermediates used in production. However, firms the world over will use the same number of units of the composite input. Thus, firms in each country will produce the same amount of output, but with a different mix of inputs.

D. Labor Markets

Workers in both sectors receive disutility e of exerting effort. In addition, workers are imperfectly monitored. So, workers have an incentive to shirk if they believe that they can avoid being detected. To deter this behavior workers are paid in excess of their marginal products and are immediately discharged if caught shirking. The threat of being fired will eliminate all shirking in equilibrium. Let ρ be the exogenous discount rate, let q be the exogenous rate at which shirking workers are detected, and let b be the exogenous rate at which non-shirking workers lose their jobs. In addition, let h_k^r be the endogenous rate at which sector r workers are hired in country k. Then, the asset value equations for a sector r worker in country k are

$$(13) \qquad \rho V_k^{ur} = h_k^r\left(V_k^{nr} - V_k^{ur}\right)$$

(14) $\rho V_k^{nr} = \Gamma w_k^r \Pi_k^{-\gamma} - e + b(V_k^{ur} - V_k^{nr})$

(15) $\rho V_k^{sr} = \Gamma w_k^r \Pi_k^{-\gamma} + (b + q)(V_k^{ur} - V_k^{sr})$

where V_k^{ur} is the expected lifetime utility of an unemployed sector r worker in country k, V_k^{nr} is the expected lifetime utility of a non-shirking sector r worker in country k, and V_k^{sr} is the expected lifetime utility of a shirking sector r worker in country k. This assumes that, if hired, an unemployed worker will not shirk and that an unemployed worker has no alternative source of income.

A necessary and sufficient condition so that workers do not shirk is $V_k^{nr} \geq V_k^{sr}$. Solving equations (13) – (15) and adhering to this inequality yields the no-shirking condition (NSC) for sector r in country k

(16) $\Gamma w_k^r \Pi_k^{-\gamma} \geq \frac{e}{q}\left[\rho + b + q + h_k^r\right]$

To complete equation (16) an expression for h_k^r must be obtained. First, consider the manufacturing sector. In any steady state equilibrium the flow into employment must equal the flow out of employment. At any given point in time there are $\ell_k n_k$ manufacturing workers employed in country k. The flow into employment in country k is then $h_k^M[M_k - \ell_k n_k]$ where M_k is the number of workers in the manufacturing sector in country k. The flow out of employment is the rate at which employed workers lose their jobs. This is given by $b\ell_k n_k$. Equating these flows and solving for h_k^M gives

(17) $h_k^M = \frac{b\ell_k n_k}{M_k - \ell_k n_k}$

Substituting this into equation (16) and doing some algebra yields the NSC for the manufacturing sector in country k

$$(18) \qquad \Gamma w_k^M \Pi_k^{-\gamma} \geq \frac{e}{q}\left[\rho + q + b/\mu_k^M\right]$$

where $\mu_k^M = (M_k - \ell_k n_k)/M_k$ is the unemployment rate in the manufacturing sector in country k. Note that when trade costs fall the left hand side of this inequality rises. Hence, the unemployment rate the ensures that this equality is satisfied must fall.

In the agriculture sector, since there is a total of one unit of labor for the economy, the flow into employment is equal to $h_k^A(1 - M_k - A_k)$ where A_k is the number of employed workers in the agriculture sector. The flow out of employment is bA_k. Equating these and solving for the hiring rate yields

$$(19) \qquad h_k^A = \frac{bA_k}{1 - M_k - A_k}$$

Substituting this into equation (14) and doing some algebra yields the NSC for the agriculture sector in country k

$$(20) \qquad \Gamma \Pi_k^{-\gamma} \geq \frac{e}{q}\left[\rho + q + b/\mu_k^A\right]$$

where $\mu_k^A = (1 - M_k - A_k)/(1 - M_k)$ is the unemployment rate in the agricultural sector in country k.

E. Income and Demand

In country k, national income can be expressed

$$(21) \qquad Y_k = A_k + w_k \ell_k n_k$$

where the first term is the income of agricultural workers and the second term is the income of manufacturing workers. Due to the Cobb-Douglas form of both the utility function and the production function for the composite good, total expenditures on manufactures in country k is given by

(22) $$E_k = \gamma Y_k + (1-\theta)P_k^M n_k x$$

where the first term is expenditure by consumers and the second term is expenditure by firms. Then, the demand for a single country k variety can be expressed

(23) $$x_k = \left(P_k^M\right)^{-\sigma}\left[E_k \Pi_k^{\sigma-1} + E_j\left(\Pi_j / \tau\right)^{\sigma-1}\right]$$

where the first term inside the brackets represents domestic demand and the second term represents foreign demand. Firms earn zero profits when the scale of production, x_k, is equal to that in equation (10). Equilibrium is now characterized by equations (3), (9), (12), (18), (20), (21), (22), and (23) which can be used to solve for the equilibrium values of P_k^M, w_k, n_k, ℓ_k, Y_k, E_k, Π_k, and A_k, given the distribution of labor, M_k, between sectors in each country.

F. Steady State Equilibrium

In any steady state equilibrium, unemployed workers must be indifferent to the sector in which they are searching for employment. So, the expected lifetime utility of an unemployed worker must be the same in each sector. In the appendix it is shown that this is equivalent to having equal hiring rates in each sector. Hence, in addition to the system of equations above being satisfied, it also must be true that in any steady state equilibrium where both agriculture and manufactures are produced in both countries

(24) $$h_k^M = h_k^A$$

for $k = 1,2$[6].

III. Model Simulation

A. Methodology

Analytical results are rare in new geography models. So, outcomes are attained largely through numerical simulations. The first step in simulating the model is to reduce it to a tractable number of equations. Equation (3) gives two price indices. Substituting equation (21) into equation (22), and combining the result with equation (23) yields two demand equations. Equations (18) and (20), then, are the four no-shirking conditions (one for each sector in each country). Finally, equation (24) gives the two steady state equations. Hence, the model can be reduced to ten equations in the ten unknowns w_k, Π_k, A_k, M_k, and n_k for $k = 1,2$.

B. Parameterization

Table 3-1 lists the values of the parameters used in the simulation.

Table 3-1: Simulation Parameters

γ	σ	θ	e	b	q	ρ
.4	5	.5	.105	.13	.5	.05

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[6] In addition, there are steady state equilibria where equation (24) is not satisfied. These are equilibria where a country devotes all of its resources to the production of a single good (i.e. manufactures or agriculture). The dynamics spelled out below make it clear that these need not be considered when deriving the diagrams that determine all of the steady state equilibria, including those where equation (24) is not satisfied.

The expenditure share in manufactures is .4. Hence, individuals spend 40% of their incomes on differentiated goods and 60% on agriculture. The elasticity of demand is equal to 5, which corresponds to a markup of price over marginal cost of 20%. The production share in intermediates is equal to .5. Thus, half of firms' revenue goes to intermediates and half to labor. The choice of $\rho = .05$ is roughly consistent with recent real rates of interest in the developed world. Since jobs arrive according to a Poisson process, $1/b$ is the average job tenure in the manufacturing sector. So, $b = .13$ corresponds to a job lasting an average of 7.7 years, the average in the European Union[7]. Finally, the choice of e implies the aggregate rate of unemployment will fall in the neighborhood of 10%.

IV. Simulation Results

A. Labor Dynamics

Since the steady state condition requires that the hiring rate be equal in both sectors, anything that increases the manufacturing hiring rate relative to the agricultural hiring rate in the larger region will encourage agglomeration and anything that decreases the manufacturing hiring rate relative to the agricultural hiring rate in the larger region discourages agglomeration. So, a logical question to ask is how will a shift in the distribution of labor affect the relative magnitudes of the manufacturing and agricultural hiring rates? The forces at work here can be separated into four effects. One of these works against the agglomeration of manufactures into a single country and will be

[7] See OECD (1997).

referred to as the *anti-agglomeration effect*. And the other three work in favor of the agglomeration of manufactures into a single country and will be referred to as the *pro-agglomeration effects.* Suppose that there is a shift in the labor distribution into the manufacturing sector in country k. First, there is the extent of competition. Increasing the number of varieties in a single region will lower the price index since more varieties are now produced there. This will reduce the demand for each individual variety and will tend to lower the manufacturing hiring rate relative to that of agriculture. This is the *anti-agglomeration effect.* Second, the lower price index reduces the cost of the intermediate good. So, firms' expenditure on intermediates will increase. This tends to increase both the manufacturing wage and the manufacturing hiring rate relative to those of agriculture. This is the forward linkage mentioned in section I. Third, an increase in the amount of labor producing manufactures in country k increases expenditure in country k since more varieties are being produced there. This tends to increase the demand for each individual variety and increase the manufacturing hiring rate relative to that of agriculture. This is the backward linkage mentioned in section I. Fourth, an effect absent from the full employment model, the fall in the price index will increase employment in both sectors. This generates a further increase in expenditure through an increase in national income. This will tend to increase the manufacturing hiring rate relative to that of agriculture. These last three effects at work are the *pro-agglomeration* effects. Which effects dominate depends on the value of trade costs.

Figure 3-1 shows, for each country, the locus of labor distributions where the hiring rate is identical in both sectors when trade costs are high ($\tau = 3$). The thin line is country 1's curve and the thick line is country 2's curve. If $M_k = 0$ then country k's entire labor force produces agriculture, and if $M_k = 1$ country k's entire labor force produces manufactures.

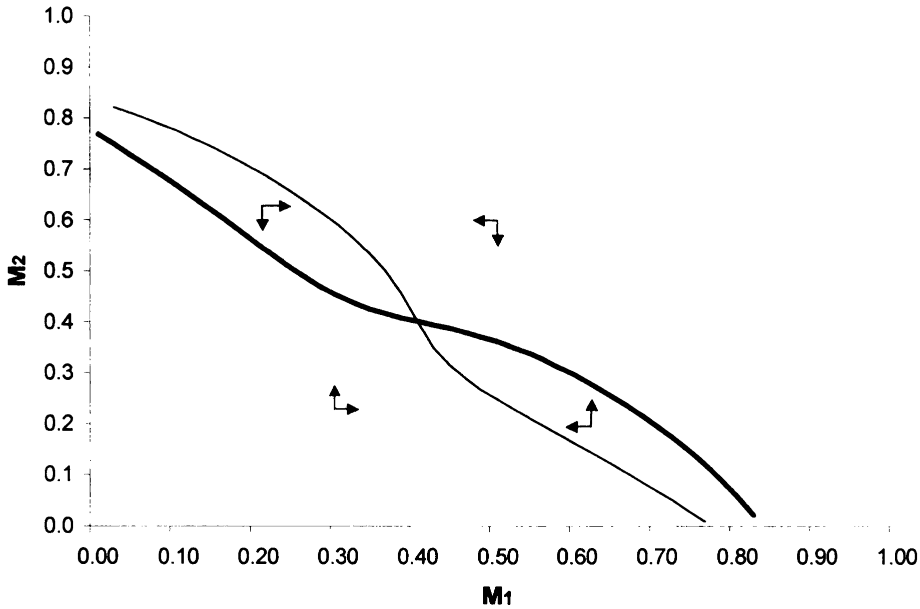

Figure 3-1: Labor Dynamics with High Trade Costs

For distributions of labor that lie below each country's curve the hiring rate is larger in the manufacturing sector so unemployed workers will shift their search efforts towards manufacturing until the hiring rates are equalized. For distributions of labor that lie above each country's curve the hiring rate is larger in the agricultural sector so unemployed workers will shift their search efforts towards agriculture until the hiring rates are equalized. It is clear from the diagram that when trade costs are high there is a single, globally stable equilibrium where both countries have γ (= .4) of the labor force in the manufacturing sector and the remainder in the agricultural sector. This will be referred to as a symmetric equilibrium. Here, the *pro-agglomeration* forces are not strong enough to combat the increased competition in the larger region.Figure 3-2 shows the same type of diagram when trade costs are low ($\tau = 1.5$).

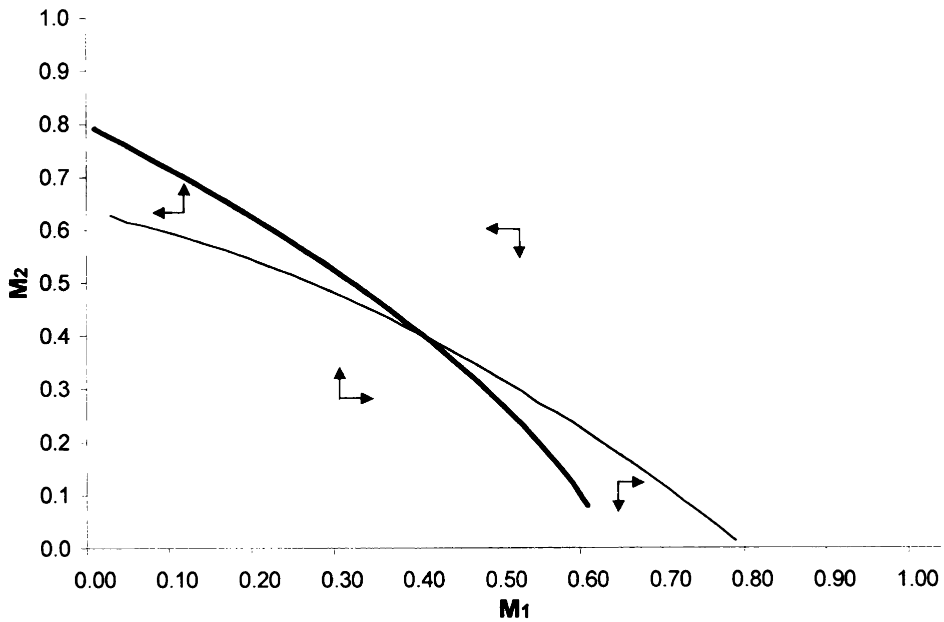

Figure 3-2: Labor Dynamics with Low Trade Costs

Here there is a saddle path leading to the same symmetric equilibrium. However, this equilibrium is now unstable. Any deviation from the symmetric equilibrium will result in one country specializing in agriculture and the other country supplying the total world demand of manufactures in addition to the remaining demand for agriculture. Such equilibria will be referred to as specialized equilibria. The particular equilibrium that will prevail depends entirely on the initial distributions of labor in both countries. The country with the larger initial base of manufacturing labor will receive the agglomeration.

Hence, if trade costs fall low enough a catastrophic core-periphery pattern will emerge where one country produces all of the world's manufactures.

Finally, Figure 3-3 shows the diagram for an intermediate value of trade costs (τ = 2.15).

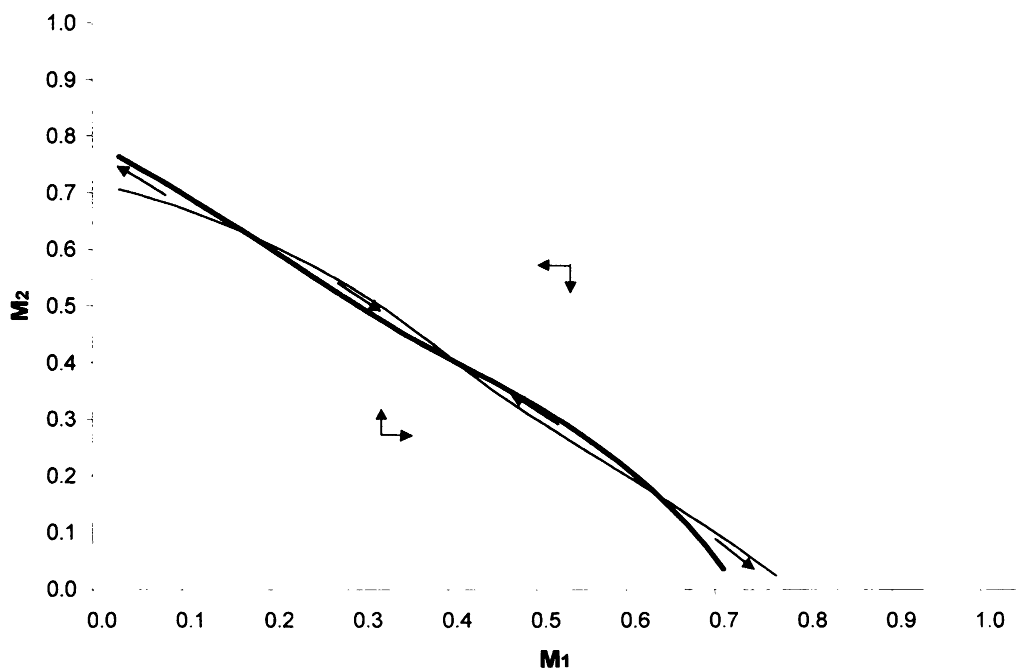

Figure 3-3: Labor Dynamics with Intermediate Trade Costs

Here there are three stable equilibria: the symmetric equilibrium where γ (= .4) of the labor force in the manufacturing sector and the remainder in the agricultural sector, country 1 specializes in agriculture, and country 2 specializes in agriculture; and two unstable equilibria at an intermediate distribution of labor between these extremes. Here a catastrophic core-periphery bifurcation will not arise unless one country's manufacturing base is considerably larger than the other's. Otherwise, a symmetric equilibrium will prevail.

B. The Structure of Equilibria

Figures 3-1 to 3-3 suggest that as trade costs fall a threshold level is reached where the stable, symmetric equilibrium breaks down. Call this level of trade costs the break point, τ(B). In addition, there is a threshold level of trade costs where a specialized equilibrium can be sustained. Call this level of trade costs the sustain point τ(S). Furthermore, as evidenced by Figure 3-3, there are levels of trade costs where both classes of equilibria are feasible. Figure 3-4 summarizes these facts with a bifurcation diagram showing the equilibrium distributions of labor as a function of the level of trade costs.

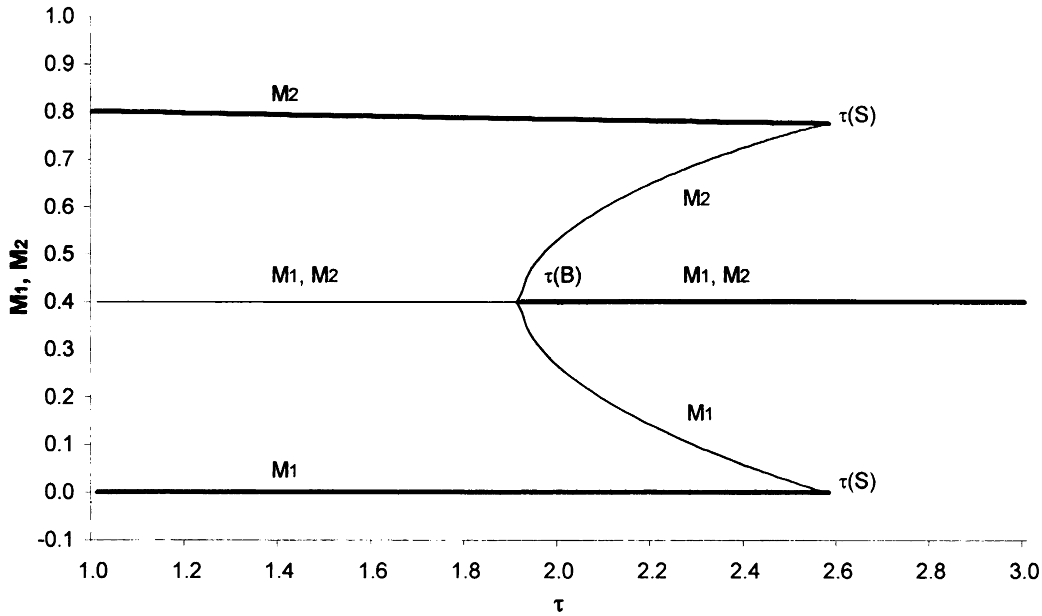

Figure 3-4: Bifurcation Diagram with Symmetric Countries

Here it is assumed that the initial distribution of labor is such that country 1 will specialize in agriculture if trade costs fall sufficiently low[8]. The thick lines represent stable equilibria and the thin lines represent unstable equilibria. What Figure 3-4 shows is that as trade costs fall over time two countries who are similar in every way except for their industrial histories will naturally divide themselves into an industrialized core and an agricultural periphery. The core will consist of the country that historically has had the larger manufacturing base and the periphery will consist of the country that historically has had the larger agricultural base[9].

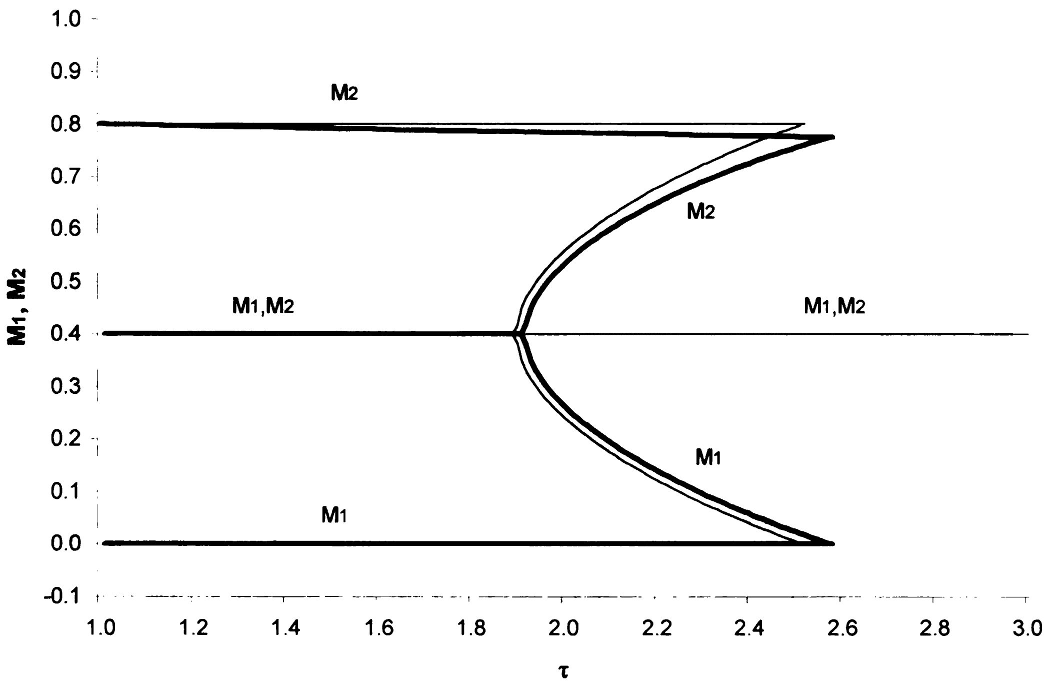

Figure 3-5: Efficiency Wage and Full-Employment Bifurcation Diagrams

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[8] The case where each country's role is revered yields a diagram identical to figure 4 with the exception that M_1 and M_2 are reversed.

[9] It may be the case that two countries industrial histories have them in a symmetric equilibrium when trade costs initially fall below the break point. In this case the country that first deviates from this equilibrium in the direction of manufacturing will become the core and the other country will become the periphery.

The diagram given in Figure 3-4 is very similar to the bifurcation diagram that can be derived from a full-employment version of this model. Figure 3-5 superimposes the bifurcation diagram from the full-employment model onto figure 3-4. The thick lines are the efficiency wage bifurcation (i.e. Figure 3-4) and the thin lines are the full-employment bifurcation. To avoid confusion in comparing this with figure 3-4 note that stable and unstable equilibria are no longer differentiated in figure 3-5. There are two striking differences between the structure of equilibria in the two models. First, both the break and sustain points are larger in the efficiency wage model. This implies that industry agglomeration is an equilibrium for a larger range of trade costs when there is unemployment due to imperfect monitoring than in a full-employment world. This is due to the effect mentioned above that is not present in the full-employment model: a fall in the price index increases employment which will increase demand for manufactures even further. Hence, starting from a random distribution of labor and a random value of trade costs agglomeration of manufacturing is more likely in the efficiency wage world than in the full-employment world.

Second, in the efficiency wage bifurcation the amount of labor devoted to manufactures in country 2 in the specialized equilibrium is smaller than in the full-employment model for positive values of trade costs (i.e. $\tau > 1$). Furthermore, as trade costs fall the two labor distributions converge. In the efficiency wage model there is some level of unemployment that would exist even in the absence of trade costs. However, if trade costs rise the demand for manufactures falls due to the wedge that trade costs drive between prices from one country to the other. Hence, in equilibrium fewer workers are required to produce this demand. The difference in these two curves can then be interpreted as the amount of unemployment that arises from the trade cost wedge in prices between regions.

C. Unemployment

How will the structure of equilibria discussed above affect unemployment at the national level in each country? The aggregate unemployment rate in country k can be expressed

(25) $U_k = 1 - A_k - \ell_k n_k$

The answer to this question, then, depends on what effects changes in trade costs and the resulting shifts in the distribution of labor have on the number of agricultural workers, firm size, and the number of varieties produced.

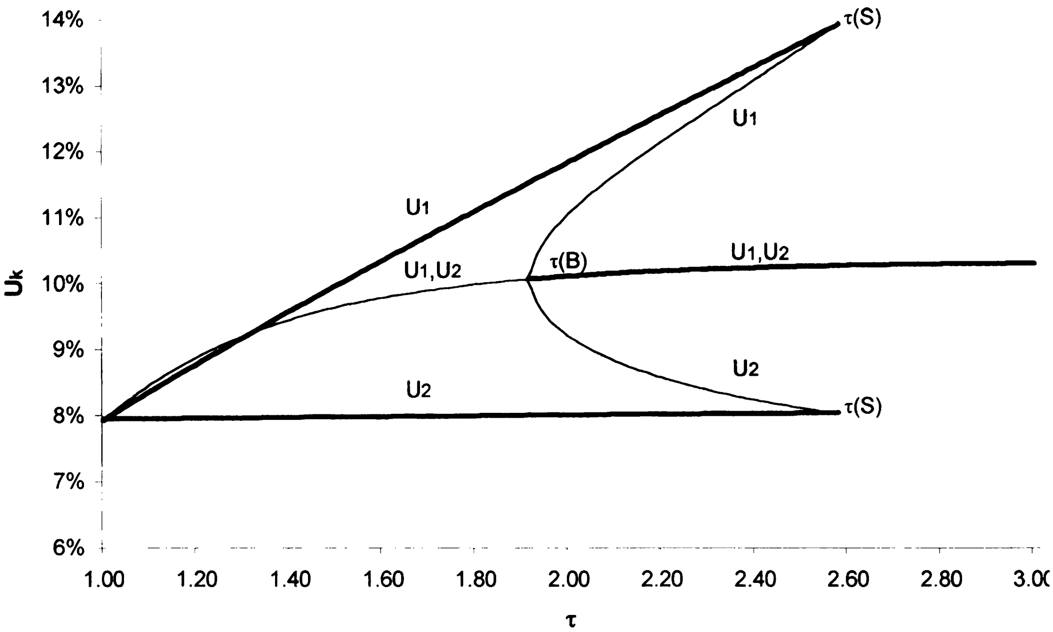

Figure 3-6: Unemployment Along the Efficiency Wage Bifurcation

Figure 3-6 shows the aggregate unemployment rate in both countries along the bifurcation depicted in figure 3-4. Again, the thick lines represent stable equilibria and the thin lines represent unstable equilibria. The lines labeled U_1,U_2 are the symmetric equilibria. The unstable lines labeled U_1 and U_2 are the unstable equilibria that arise at an intermediate level of trade costs. And, the stable lines labeled U_1 and U_2 are the core-periphery equilibria. There are several significant features of this diagram. First, if the distribution of labor remains fixed at the symmetric equilibrium, unemployment is strictly increasing in trade costs. This is evident from the strictly upward slope of the unemployment curve along the symmetric equilibria. When trade costs fall real wages increase which allows the manufacturing sector to expand increasing employment in this sector. Unemployment must be identical in both sectors since wages are the same in both sectors or else both no-shirking conditions will not be satisfied. This allows employment to expand in the agriculture sector. Since, employment expands in both sectors the aggregate unemployment rate must fall. In short, increased employment in the manufacturing sector creates demand for agriculture allowing both sectors to expand.

Second, if the distribution of labor remains fixed at a specialized equilibrium the aggregate unemployment rate is strictly increasing in trade costs. Again, this can be seen by the strictly upward slope of the unemployment curves for both countries along the specialized equilibria. The intuition is similar. In country 1, as trade costs fall real wages increase which increases the level of employment required to deter shirking in the agriculture sector. Since agriculture is the only industry in country 1 this will increase aggregate employment in country 1. In country 2, the intuition is the same as in the symmetric equilibrium. When trade costs fall real wages rise which allows the manufacturing sector to expand. Unemployment must be the same in both sectors since wages are the same in both sectors or both no-shirking conditions will not be satisfied. This allows employment to expand in the agriculture sector. Since, employment expands in both sectors the aggregate unemployment rate must fall.

Third, when country 1 specializes in agriculture country 2's unemployment falls compared to the symmetric equilibrium and country 1's unemployment may rise or fall depending on the value of trade costs. If country 1 specializes in agriculture then real wages with respect to manufactures will rise in country 2 and fall in country 1. Since demand favors local products the net result will be an increase in worldwide demand for manufactures. Since country 2 is the only producer of manufactures employment must rise in the country 2 manufacturing sector. Again, these new workers create demand for agriculture which allows the agriculture sector to expand in country 2. Since employment increases in both sectors the aggregate unemployment rate will fall in country 2. In country 1 there are two competing forces at work. First, the real wage of agriculture workers falls. To keep the no shirking condition satisfied either the wage must rise or employment must fall in the country 1 agriculture sector. Since agriculture is taken as numeraire this tends to reduce employment. On the other hand, the increased employment in country 2 creates more demand for agriculture which tends to increase employment in country 1. When trade costs are high the former effect dominates and unemployment rises when the economy moves from a symmetric to an agglomerated equilibrium. When trade costs are low enough the latter effect dominates and unemployment falls when the economy moves from a symmetric equilibrium to an agglomerated equilibrium.

Finally, as trade costs approach zero the unemployment rates of the two countries converge. As trade costs fall real wages converge since the nominal wage is identical in both countries. If real wages are converging then the employment levels required to deter shirking will also grow closer to one another until they are identical when trade costs fall to zero (i.e. $\tau = 1$).

What all of this suggests is that, in the short term, if a catastrophic core-periphery bifurcation does occur the country that receives manufacturing firms will enjoy an employment benefit while the country that loses manufacturing firms will suffer an employment penalty. As was discussed above, the country that historically has had a large manufacturing base (i.e. the developed world) will gain while the country that has historically had a large agricultural base (i.e. the less developed world) will lose. So, the initial agglomeration will further separate the less developed countries of the world from the industrialized countries of the world. However, if trade costs continue to fall the unemployment rates of the core and the periphery will begin to converge, but will not completely converge unless the costs of trade fall to zero. So, as trade costs fall over time there is a period of natural divergence followed by a period of natural convergence. It is clear that no matter where the world is in this cycle the developed world gains employment from globalization. The answer is less clear for the less developed world. It depends on where the world is in this cycle. However, in the very long term if trade costs continue to fall to very low levels the less developed world will see a gain in employment.

V. Cross-Country Asymmetry

The analysis now turns to the situation where the rate of job tenure differs between regions. Why might job tenure differ between countries that are otherwise identical? First, as Shapiro-Stiglitz (1984) notes, the breakup rate, and hence tenure, is ultimately linked to the employment package offered by firms. In the model presented above the employment package includes only a wage. In the real world, the package will include any number benefits that the firm chooses to offer its employees. If these services are simply available for employees to use at no additional labor cost, it is conceivable that the level of these services could differ between countries based on each country's particular history. Second, reactions of the public sector to unemployment may also differ from country to country where local governments determine distinct policy reactions. Given these, it is probable that tenure rates will differ from one country to the next.

A. Labor Dynamics

In efficiency wage models such as this the inverse of the breakup rate, b, is the expected rate of tenure. So, by letting the breakup rate vary between countries the effects of varying job tenure can be analyzed. How will this affect the labor dynamics of the model? When the breakup rate is not the same in both countries there is a greater incentive to shirk in the country with the higher breakup rate (i.e. lower tenure). Hence, there is a fifth force at work in determining the labor dynamics of the model: a *shirking effect*. The shirking effect will tend to draw manufacturing into the high tenure country through its effect on employment. The shirking effect leads to higher employment in the high tenure country[10]. Since demand favors local over non-local products this allows manufacturing to expand more in the high tenure country than in the low tenure country. Hence, the high tenure country will tend to have a larger share of manufactures than the low tenure country.

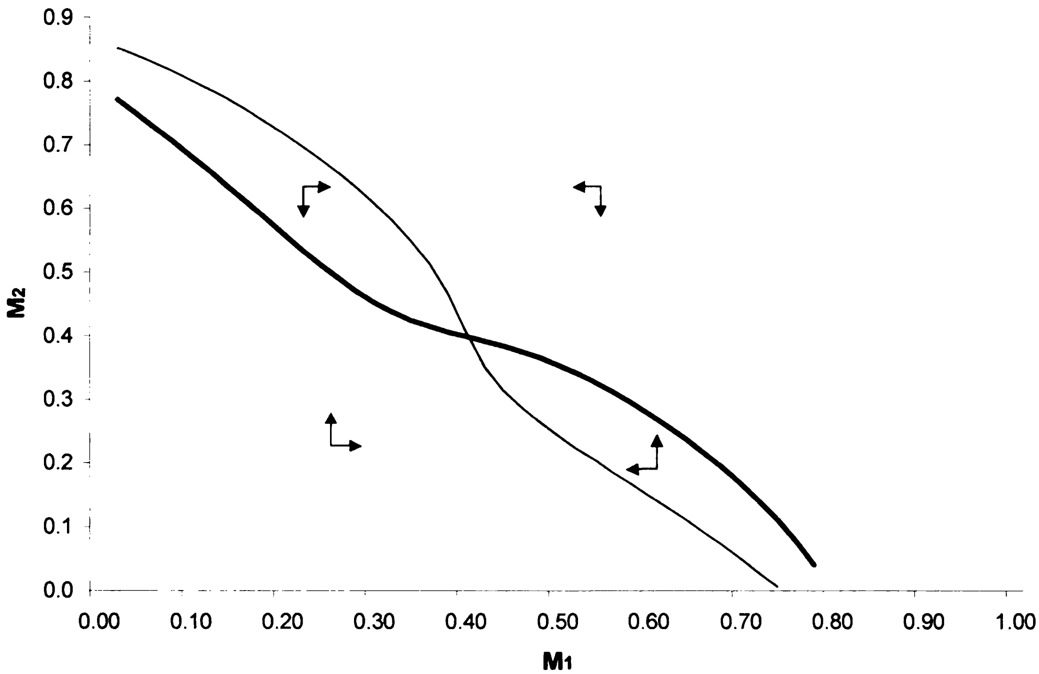

Figure 3-7: Labor Dynamics for Asymmetric Countries and High Trade Costs

Without loss of generality, suppose that the breakup rate is lower in region 1. The results that follow were obtained through numerical simulations with $b_1 = .1$, $b_2 = .16$, and all other parameters as listed in Table 3-1. Figure 3-7 shows the locus of labor distributions for which the hiring rate is identical in both sectors when trade costs are high ($\tau = 3$). The thin line is country 1's curve while the thick line is country 2's curve. Just as in figure 3-1, distributions of labor that lie below each country's curve will result

[10] This can be confirmed through inspection of equation (18).

in a larger hiring rate in the manufacturing sector so unemployed workers will shift their search efforts towards manufacturing until the hiring rates are equalized. And, distributions of labor that lie above each country's curve will result in a larger hiring rate in the agricultural sector so unemployed workers will shift their search efforts towards agriculture until the hiring rates are equalized. Here, there is a single, globally stable equilibrium, just as in figure 3-1. However, there is one notable difference: when country 1 has a higher tenure rate than country 2 the globally stable equilibrium is skewed with a higher proportion of the labor force in country 1 devoted to manufactures than in country 2[11]. However, the equilibrium is not far from the symmetric equilibria discussed above. Hence, equilibria in the neighborhood of a symmetric equilibrium will be referred to as *nearly symmetric* equilibria. This slight asymmetry should be expected since the shirking effect allows manufacturing to expand slightly further in country 1 than in country 2.

Figure 3-8 shows the case when trade costs are low ($\tau = 1.5$). As in figure 3-2, there is a saddle path leading to an unstable equilibrium. However, while it is still nearly symmetric it is not the same equilibrium as in figure 3-7. Here the unstable equilibrium is skewed with a higher proportion of the labor force engaged in manufacturing in country 2 than in country 1[12]. This result is, again, due to the shirking effect. Given the skewness of the nearly symmetric equilibrium, if the world begins at a random distribution of labor in both countries it is more probable that country 2, the low tenure country, will specialize in agriculture and country 1, the high tenure country, will specialize in manufacturing. So, while industrial history is still the major component

[11] The equilibrium labor distributions are $L_1 = .402787$ and $L_2 = .397052$.
[12] The equilibrium labor distributions are $L_1 = .379425$ and $L_2 = .421593$.

determining which country will receive the agglomeration of manufacturing, differing labor market parameters do have an effect.

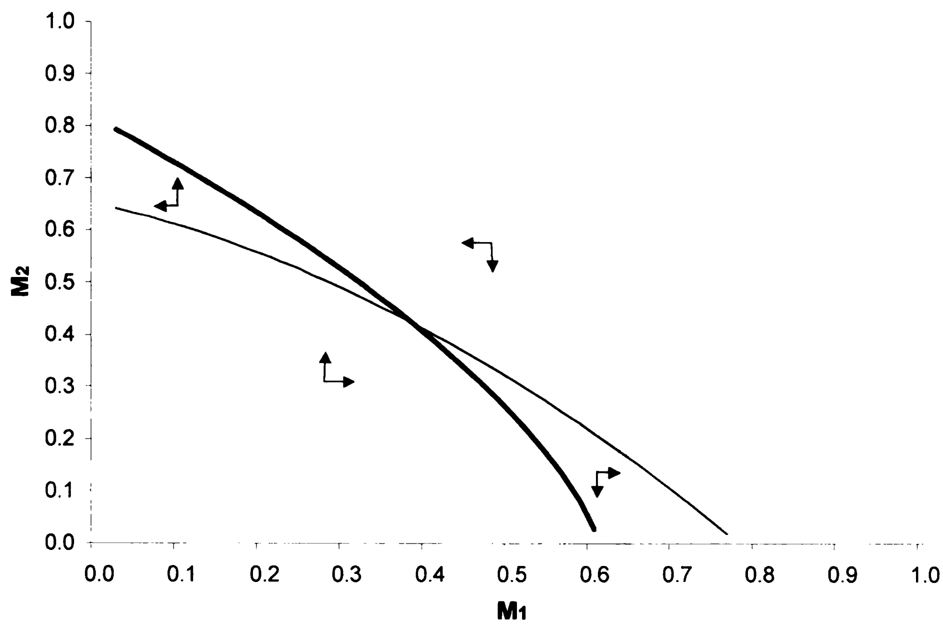

Figure 3-8: Labor Dynamics for Asymmetric Countries and Low Trade Costs

Finally, figure 3-9 shows the case of an intermediate value of trade costs (τ = 2.15). As in figure 3-3 there are three stable equilibria: a nearly symmetric equilibrium, country 1 specializes in agriculture, and country 2 specializes in agriculture; and two unstable equilibria at an intermediate distribution of labor between these two extremes. Again, a catastrophic core-periphery bifurcation will not arise unless one country's manufacturing base is sufficiently larger than the other's. However, the higher tenure in country 1 tips the scales in their favor. That is, if agglomeration into country 2 is to be sustained they will need a higher proportion of the manufacturing base than country 1 does to sustain agglomeration there.

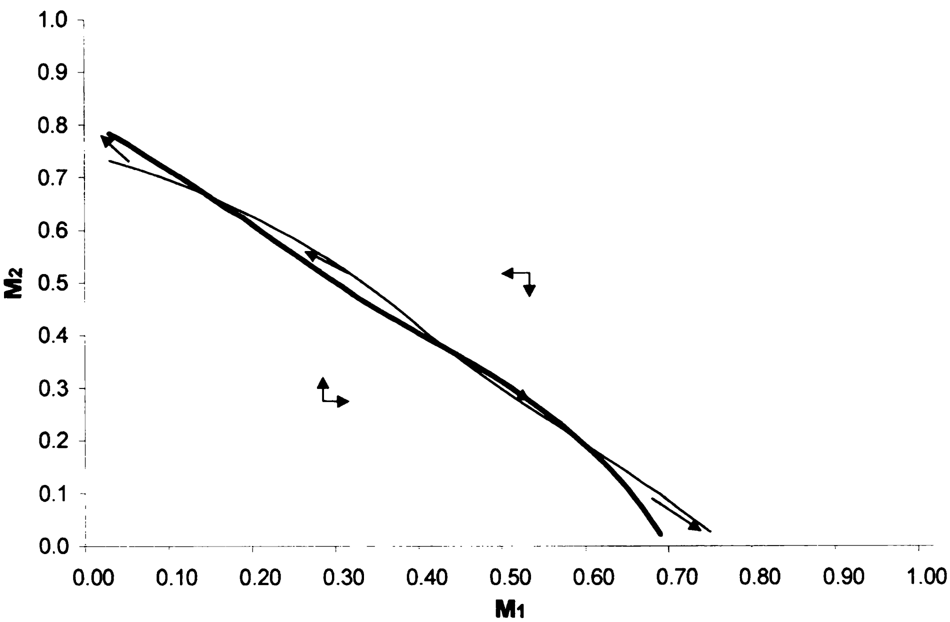

Figure 3-9: Labor Dynamics for Asymmetric Countries and Intermediate Trade Costs

B. The Structure of Equilibria

To get a complete understanding of the structure of equilibria in the asymmetric case it is useful to look at the bifurcation diagram given in figure 3-10. Again, thick lines represent stable equilibria while the thin lines represent unstable equilibria. When trade costs are very high there is only one stable equilibrium for a given value of trade costs. These are the nearly symmetric equilibria with country 1 having slightly higher proportion of its workers in manufacturing than country 2 and are represented by the thick black lines. Then, when trade costs fall to the country 1 sustain point, $\tau_1(S)$, a stable equilibrium in which country 1 produces all of the world's manufactures and country 2 specializes in agriculture can be sustained. As trade costs fall further to the country 2 sustain point, $\tau_2(S)$, an additional stable equilibrium in which country 2 produces all of the world's manufactures and country 1 specializes in agriculture can also be sustained. These equilibria are represented by the thick gray lines. If trade costs fall below the break point, $\tau(B)$, the nearly symmetric equilibrium is no longer stable. These unstable equilibria are represented by the thin black lines.

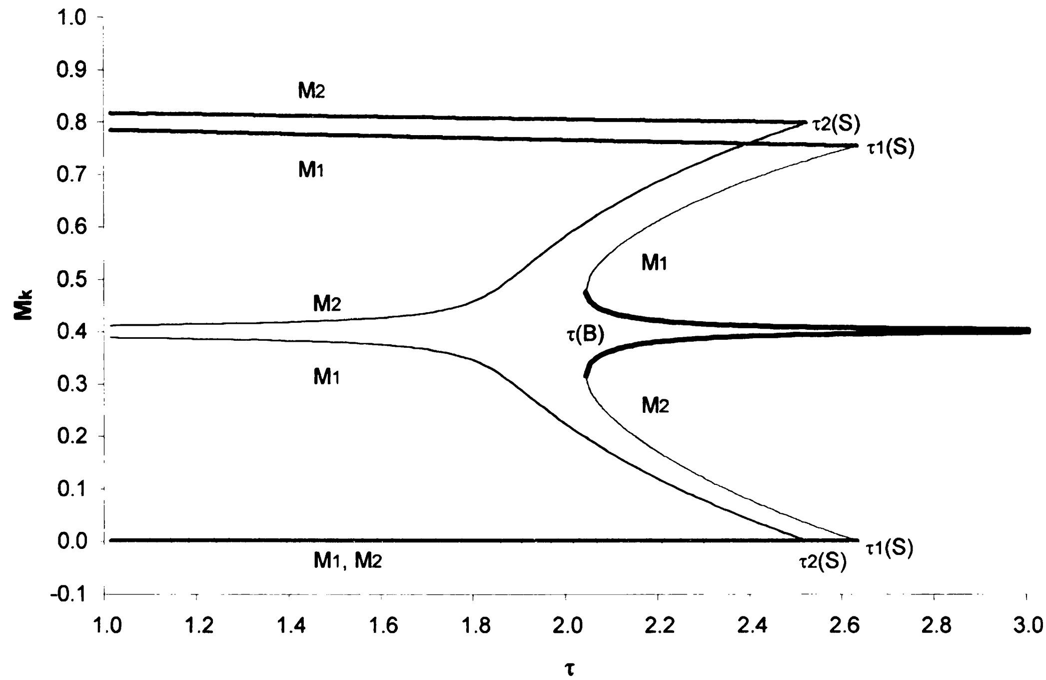

Figure 3-10: Bifurcation Diagram for Asymmetric Countries

There are two other classes of equilibria depicted: one where country 1 has a higher proportion of its workforce in manufacturing than country 2 and one where the reverse is true. These are the unstable equilibria that arise when trade costs take on an intermediate value and are represented by the thin gray lines. Just as in the case of symmetric countries, as trade costs fall over time the world will naturally divide itself into an industrialized core and an agricultural periphery. However, the sustain point is now larger in country 1, the high tenure country, than in country 2 because the shirking effect allows manufacturing to expand further in the high tenure country. Hence, for a random distribution of labor and a random value of trade costs it is more likely that agglomeration will arise in country 1 than in country 2.

C. Unemployment

How will the structure of equilibria in an asymmetric world affect the equilibrium levels of unemployment in each country? Again, the unemployment rate for country k is expressed as in equation (25). Figure 3-11 shows the equilibrium unemployment rates in each country along the stable equilibria depicted in figure 3-10. The thick black lines are the nearly symmetric equilibria; the thick gray lines are the equilibria where country 1 produces all of the world's manufactures; and the thin black lines are the equilibria where country 2 produces all of the world's manufactures.

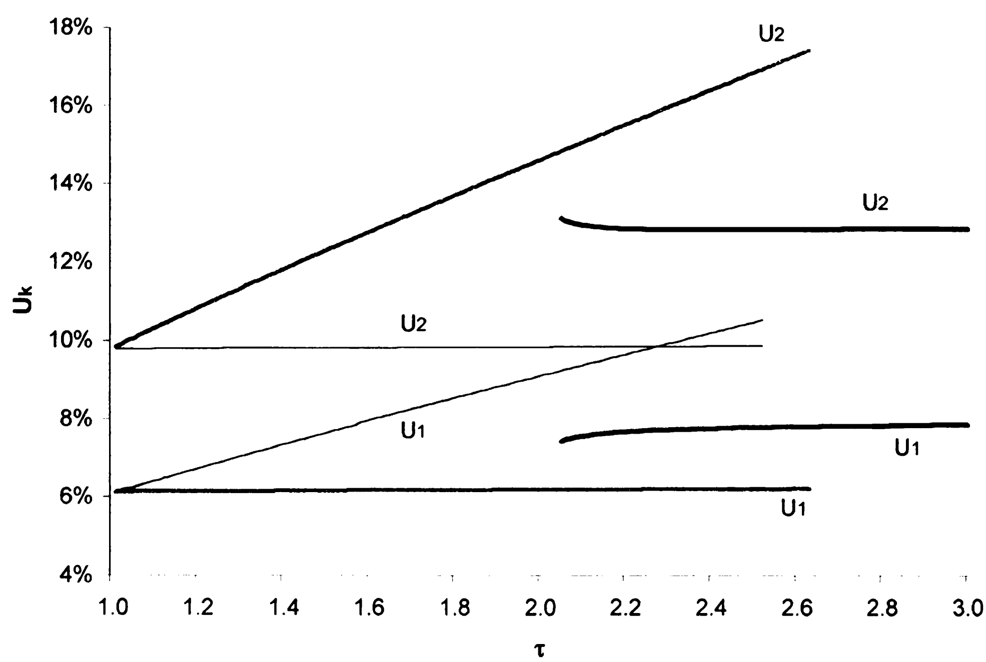

Figure 3-11: Unemployment with Asymmetric Countries

There is one major difference between figure 3-11 and figure 3-6. When countries are asymmetric if trade costs fall low enough unemployment will be lower in country 1, the high tenure country, for all classes of stable equilibria. This is a direct result of the effect that the lower rate of job breakup in country 1 has on the unemployment rate that will deter workers from shirking. A lower breakup rate lowers the unemployment rate that satisfies the no-shirking condition. So, one would expect that the unemployment rate would be higher in the low tenure country. There is one exception to this when manufacturing production is located entirely in country 2 and trade costs are high. In this case, trade costs are sufficiently high so that the higher price index in country 1 has a larger effect on the unemployment rate then does the lower rate of job tenure. However, as trade costs fall this trend reverses and the result is, as one would expect, that unemployment is lower in country 1.

Assuming that the developed world has higher rates of tenure than the developing world the pattern is similar to the symmetric case. Over time as trade costs fall there is a period of divergence followed by a period of convergence. However, absolute convergence now cannot occur even if trade costs fall to zero. No matter where in the cycle the world is currently the developed world will experience positive employment gains from globalization. Again, for the developing world the impact of globalization on employment depends on where the world lies: in the stage of convergence or the stage of divergence.

VI. Conclusion

The model presented in this chapter constructs a two-country new geography model to examine the relationships between falling trade costs and unemployment. It is shown that as trade costs fall over time the world will naturally divide itself into an industrialized core and an agricultural periphery. The core will consist of countries with a traditionally large manufacturing base (i.e. the developed world) and the periphery will consist of countries with a traditionally large agricultural base (i.e. the less developed world). In such a model where unemployment is caused by imperfect monitoring there is an additional push towards agglomeration in the form of expanding employment. As a result, agglomeration is more likely to occur in a world where there are efficiency wages than in a world devoid of unemployment.

It is also shown that in world of imperfect monitoring and symmetric countries unemployment is increasing in trade costs for fixed distributions of labor. However, if the world reaches a point where agglomeration occurs the industrialized core gains and the less developed periphery loses from the initial bifurcation. However, if trade costs continue to fall, the unemployment rates of the two will begin to converge. Unequivocally, falling trade costs due to globalization have a positive effect on the core countries of the developed world. Whether current global trends are good for the less developed world depends on which stage the world is currently experiencing: divergence or convergence. However, in the extreme long term, globalization will help both groups as trade costs fall lower and lower.

Finally, the model shows that if country's labor markets differ in terms rates of job tenure it can tip the scales of agglomeration in their direction. Countries with higher tenure are more likely to be on the receiving end of an agglomeration of manufacturing than are countries with lower tenure rates. Furthermore, countries with higher tenure rates will reap a larger benefit if agglomerations do arise within their borders. Even if free trade is attained, the low tenure countries will always have a disadvantage in terms of employment. In addition, the same conclusions must be reached about the effects of globalization on employment. Globalization will undeniably have a positive employment effect in the both developed and developing worlds in the long term. However, the short term effects in the less developed countries depends on where the world economy is the cycle of divergence and convergence.

Chapter 4:

A Two-Region Model with Search Frictions

I. Introduction

The goal of this chapter, again. will be to extend the Krugman (1991) framework to include unemployment. The particular form of unemployment used here is a variant of the Diamond (1982) model that accounts for search frictions in the labor market. The impact of this augmentation on the labor dynamics of the model varies depending on the homogeneity of the stochastic matching technology. It is shown below that when the matching function exhibits constant returns to scale the forces that shape agglomeration patterns are identical to those in the Krugman (1991) model. Hence, agglomeration is no more nor less likely than in a world of full-employment. However, if the matching function exhibits increasing returns to scale then agglomeration not only becomes more likely but can be sustained for any combination of the model's parameters. In this case there is a stark difference between the full-employment world and one where workers must seek out job opportunities.

The impact on unemployment of adding search frictions to the labor market also varies depending on the homogeneity of the matching technology. If the matching function exhibits constant returns to scale the number of matches is constant regardless of the size of each region. Hence, agglomeration has no impact on the economy's unemployment rate. However, if the matching technology exhibits increasing returns to scale the number of matches increases as the population of a given region grows. In this case agglomeration will provide an additional economic benefit through lower rates of unemployment.

The case where rates of job turnover are permitted to vary from region to region is also discussed. The source of such asymmetries is not modeled, however these asymmetries do exist in the real world. It is shown that regions with lower rates of job separation will attract workers by offering higher expected lifetime utilities. Hence, agglomeration is more likely to occur in such regions in regions with higher turnover. In addition, such agglomerations will result in lower economywide unemployment regardless of the returns to scale in the matching technology.

Section II of the paper describes the model. Section III discusses the simulation techniques used to derive the model's results. Section III derives the model's results when the matching technology exhibits constant returns to scale. Section IV derives the model's results when the matching technology exhibits increasing returns to scale. Section V derives the model's results when labor markets are not symmetric between regions. And finally, section VI offers some concluding remarks and suggestions for further research.

II. The Model

The model builds on the framework first developed by Dixit-Stiglitz (1977) and its extensions by Krugman (1979, 1980, 1991). Consider an economy in which there are two types of final goods: Agriculture (A) and manufactures (M); three factors of production: farm labor, type A labor, and type B labor; and two regions. Farm workers are assumed to be perfectly immobile between regions[1], while type A and type B workers may locate in either region. All workers are endowed with one unit of leisure that is inelastically supplied as labor services. Agriculture is produced using only farm labor while production of manufacturing goods requires an intermediate input consisting of both type A and type B labor. The size of each type of labor force is normalized to one.

A. Agricultural Production

Farm workers are assumed to be evenly distributed throughout the economy with ½ located in each region. Agriculture is produced under constant returns to scale. The unit labor requirement is one and agriculture is taken as numeraire so that its price and the wage of farm workers is equal to unity. In addition, the simplifying assumption that agriculture can be transported between regions at no cost is made[2].

B. Preferences

All individuals in the economy share the utility function

(1) $$U = X^{\gamma} A^{1-\gamma}$$

for $0 < \gamma < 1$, where X is consumption of an aggregate of differentiated goods, and A is consumption of agriculture. Hence, consumers will spend a proportion γ of their incomes on manufactured goods and a proportion $(1- \gamma)$ of their incomes on agriculture. The differentiated goods aggregate is given by the CES subutility function

[1] This assumption is equivalent to assuming that farm labor is tied to the land.
[2] Including trade costs on the agricultural good in these types of models can alter the results by shrinking the range of parameters for which agglomeration is an equilibrium. For more on this see Davis (1998), Fujita et al. (1999), and Rauch (1999).

(2) $$X = \left[\sum_{i=1}^{n_1} (x_{i1})^{\frac{\sigma-1}{\sigma}} + \sum_{i=1}^{n_2} (x_{i2})^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}$$

where n_k is number of varieties produced in region k, x_{ik} is the consumption of variety i produced in region k, and $\sigma > 1$ is the elasticity of substitution between varieties. From equation (2) it is evident that individuals desire variety and will consume some amount of each variety that is produced. The price index over manufactured goods for an individual residing in region k is given by

(3) $$\Pi_k = \left[n_k p_k^{1-\sigma} + n_j p_j^{1-\sigma} \tau^{1-\sigma} \right]^{\frac{1}{1-\sigma}}$$

where p_k is the price of a single variety produced in region k, and $\tau > 1$ are iceberg transportation costs; in order for one unit of the good to arrive at its destination τ units must be shipped. There are two noteworthy features of this price index. First, the higher the share of manufactures produced in region k the smaller is the region k price index. Hence, the price of manufactures as a whole is decreasing in regional agglomeration. Second, the higher are trade costs the larger is the price index and the more expensive are manufactures as a whole. Solving the utility maximization problem and substituting demands back into (1), utility for a type j worker in region k can be expressed in its indirect form as

(4) $$V_{jk} = \Gamma w_{jk} \Pi_k^{-\gamma}$$

for j = {A,B,F} where $\Gamma = \gamma^{\gamma}(1-\gamma)^{1-\gamma}$.

C. Manufacturing Production

Firms producing manufactures require the use of a Leontief composite input, θ_k, with fixed coefficients of each type of labor

(5) $\theta_k = \min\{\ell_{Ak}, \ell_{Bk}\}$

where ℓ_{jk} is the amount of type j labor in region k used in the production of the composite input. Let w_{jk} be the wage of a type j worker for j = {A,B} employed in region k. Then, the unit price of θ_k is $w_{Ak} + w_{Bk}$. A fixed and marginal input of θ_k is used in production. The amount of θ required for firm i in region k to produce m_{ik} units of manufacturing output is given by

(6) $\theta_{ik} = \alpha + \beta m_{ik}$

where α and β are the fixed and marginal inputs respectively. Since products are differentiated each firm will view itself as a monopolist with respect to their own variety. Each firm faces an elasticity of demand of σ so firms will set price $\sigma/(\sigma-1)$ over marginal cost. The price set by region k firms, then, can be expressed

(7) $p_k = \left(\frac{\sigma}{\sigma-1}\right)\beta\left(w_{Ak} + w_{Bk}\right)$

New firms are free to enter the market and will do so until profits are driven to zero. The equilibrium condition, then, is that the price charged by each firm must equal firms' average cost. The average cost of a firm in region k is given by $[(\alpha + \beta x_{ik})(w_{Ak} + w_{Bk})]/x_{ik}$. After setting this expression equal to equation (7) and choosing units of measurement for the final manufacturing good such that $\alpha = 1/\sigma$ the scale of each firm is given by

(8) $$x = \frac{1}{\beta}\left(\frac{\sigma - 1}{\sigma}\right)$$

Note that all firms produce the same amount of output regardless of factor prices or location. Substituting equation (8) into equation (6) gives each firm's demand for the composite input

(9) $$\overline{\theta} = 1$$

So, each firm will require the amount of the composite input that is produced by a single type A-type B worker match.

D. The Search Process

Type A and type B workers must seek one another out in order to produce the composite input. When two workers in region k become matched they produce one unit of θ_k each period until they become separated which happens at rate per unit time s. There are L_{Ak} potential type A workers and L_{Bk} potential type B workers in region k devoted to production of θ_k. Let U_{jk} be the number of unemployed type j workers in region k. Workers are brought together by the stochastic matching function $m(U_{Ak},U_{Bk})$. It is assumed that $m(\cdot)$ has the following characteristics:

(10A) $m(0,U_{Bk}) = m(U_{Ak},0) = 0$

(10B) $m(U_{Ak},U_{Bk})$ is increasing in U_{Ak} and U_{Bk}

(10C) $m(U_{Ak},U_{Bk})$ is homogeneous of degree $n \geq 1$

(10D) $m(U_{Ak},U_{Bk})/U_{jk}$ is decreasing in U_{jk}

(10E) $m(U_{Ak},U_{Bk}) \leq \min\{U_{Ak},U_{Bk}\}\ \forall\ U_{Ak},U_{Bk} \in [0,1]$

Let W^E_{jk} and W^U_{jk} be the expected lifetime wealth of employed and unemployed type j agents in region k respectively. Then, the asset value equations for type A workers in region k are given by

$$(11) \qquad rW^U_{Ak} = q_{Ak}(U_{Ak}, U_{Bk})(W^E_{Ak} - W^U_{Ak})$$

$$(12) \qquad rW^E_{Ak} = \Gamma w_{Ak} \Pi_k^{-\gamma} - s(W^E_{Ak} - W^U_{Ak})$$

where $q_{Ak}(U_{Ak}, U_{Bk}) = \dfrac{m(U_{Ak}, U_{Bk})}{U_{Ak}}$ is the rate at which type A searchers become matched with type B searchers in region k. Similarly the asset value equations for type B workers in region k are given by

$$(13) \qquad rW^U_{Bk} = q_{Bk}(U_{Ak}, U_{Bk})(W^E_{Bk} - W^U_{Bk})$$

$$(14) \qquad rW^E_{Bk} = \Gamma w_{Bk} \Pi_k^{-\gamma} - s(W^E_{Bk} - W^U_{Bk})$$

where $q_{Bk}(U_{Ak}, U_{Bk}) = \dfrac{m(U_{Ak}, U_{Bk})}{U_{Bk}}$ is the rate at which type B searchers become matched with a type A searchers in region k.

Using basic linear algebra techniques equations (11) & (12) and (13) & (14) can be solved for W^i_{jk} for i = E,U. Then, the surplus of finding a job for each type of worker can be expressed

$$(15) \qquad W^E_{Ak} - W^U_{Ak} = \frac{\Gamma w_{Ak} \Pi_k^{-\gamma}}{r + s + q_{Ak}(U_{Ak}, U_{Bk})}$$

$$(16) \qquad W^E_{Bk} - W^U_{Bk} = \frac{\Gamma w_{Bk} \Pi_k^{-\gamma}}{r + s + q_{Bk}(U_{Ak}, U_{Bk})}$$

A pair of matched workers bargains over the total surplus generated by the match. That is, they bargain over $W^E_{Ak} - W^U_{Ak} + W^E_{Bk} - W^U_{Bk}$. It is assumed that they arrive at the Nash bargaining solution where the surplus is shared equally between the two parties. So, setting equations (15) and (16) equal to one another one can solve for the relative wage

$$(17) \qquad \frac{w_{Ak}}{w_{Bk}} = \frac{r + s + q_{Ak}(U_{Ak}, U_{Bk})}{r + s + q_{Bk}(U_{Ak}, U_{Bk})}$$

This equation completely defines the bargaining solution.

E. The Location Decision

In addition to the bargaining condition, in any steady state equilibrium the number of matches must equal the number of separations for both types of workers

$$(18A) \quad m(U_{Ak}, U_{Bk}) = (L_{Ak} - U_{Ak})s$$

$$(18B) \quad m(U_{Ak}, U_{Bk}) = (L_{Bk} - U_{Bk})s$$

The location decision of unemployed workers is made by comparing the expected lifetime utility of searching in each region. After a bit of algebra, the location variable for a type j worker, $\Lambda_j = W_{j1}^U / W_{j2}^U$, can be expressed

$$(19) \qquad \Lambda_j = \left(\frac{\Pi_1}{\Pi_2}\right)^{-\gamma} \left(\frac{w_{j1}}{w_{j2}}\right) \left(\frac{q_{j1}(U_{A1}, U_{B1})}{q_{j2}(U_{A2}, U_{B2})}\right) \left(\frac{r + s + q_{j2}(U_{A2}, U_{B2})}{r + s + q_{j1}(U_{A1}, U_{B1})}\right)$$

If this measure exceeds unity unemployed workers will migrate into region 1, and if this measure is less than unity unemployed workers migrate into region 2. Only when equation (19) equals unity will the economy be in a steady state equilibrium.

E. Regional income and Demand

The total income of persons located in region k is given by

$$(20) \qquad Y_k = .5 + w_{Ak}(L_{Ak} - U_{Ak}) + w_{Bk}(L_{Bk} - U_{Bk})$$

where the first term is the income of farm workers, and the final two terms are the incomes of employed type A and type B workers respectively. Since preferences take the Cobb-Douglas form, region k expenditure on differentiated products is

$$(21) \quad E_k = \gamma Y_k$$

Then, demand for region k products can be expressed

$$(22) \quad m_k = p_k^{-\sigma}\left[E_k \Pi_k^{\sigma-1} + E_j\left(\Pi_j^{\sigma-1}/\tau\right)^{\sigma-1}\right]$$

where the first term in brackets represents local demand and the second term represents non-local demand. Firms will make zero profits if they produce at the scale given in equation (8). Note that if expenditure is equal in both regions region k firms will see a larger proportion of its demand coming from local consumers versus non-local consumers. Hence, demand will favor local products since individuals do not have to pay transport costs on these goods. Equilibrium is now characterized by equations (3), (7), (17), (18), (19), (20), (21), and (22) which can be used to solve for the equilibrium values of p_k, Π_k, w_{Ak}, w_{Bk}, Y_k, , E_k, U_{Ak}, and U_{Bk}.

III. Model Simulation

A. Potential Steady State Labor Distributions

With two types of manufacturing workers the set of possible labor distributions is very large. In fact, in the model described above it is infinite. Since a steady state solution is the desired result it would be prudent to narrow the set of all labor distributions to only those that are potential steady state equilibria. Proposition 1 accomplishes this task.

Proposition 1: *In any steady state equilibrium $L_{A1} = L_{B1}$.*

<u>Proof</u>: In any steady state equilibrium equation (19) must equal unity for j = A,B. Solving each of these equalities for the relative price index yields

$$(23)\qquad \left(\frac{\Pi_1}{\Pi_2}\right)^{-\gamma} = \left(\frac{w_{j2}}{w_{j1}}\right)\left(\frac{q_{j2}(U_{j1},U_{j2})}{q_{j1}(U_{j1},U_{j2})}\right)\left(\frac{r+s+q_{j1}(U_{j1},U_{j2})}{r+s+q_{j2}(U_{j1},U_{j2})}\right) \quad \text{for } j = A, B$$

This gives the price index as a function of the parameters of the model and the type j variables. Since the left-hand side of this is identical for all workers in the economy, the right-hand side for type A workers must equal the right-hand side for type B workers Using this and substituting the relative wage from equation (17) gives

$$(24)\qquad \left(\frac{q_{A2}(U_{A1},U_{A2})}{q_{A1}(U_{A1},U_{A2})}\right) = \left(\frac{q_{B2}(U_{B1},U_{B2})}{q_{B1}(U_{B1},U_{B2})}\right)$$

Substituting $q_{jk}(U_{jk},U_{jk}) = m(U_{jk},U_{jk})/U_{jk}$ for j = {A,B}, equation (24) reduces to $U_{A1}/U_{B1} = U_{A2}/U_{B2}$. Since there are the same number of matched workers of each type in each location if $L_{Ak} = L_{Bk}$ then $U_{Ak} = U_{Bk}$ and the economy is in a steady state. If $L_{Ak} > L_{Bk}$ then $U_{Ak} > U_{Bk}$ and $U_{Ar} < U_{Br}$. Hence, $U_{A1}/U_{B1} \neq U_{A2}/U_{B2}$ so this cannot constitute a steady state equilibrium. A similar argument yields the same result when $L_{Ak} < L_{Bk}$. Q.E.D.

Intuitively, this result makes perfect sense. If there are not the same number of workers of each type in each region than it would always make sense for a worker to migrate to the region where she is scarce since she would have a higher likelihood of becoming employed there and her share of the bargaining solution would be larger. Given this result attention can be now be drawn only to those cases where there are the same number of workers of each type in both regions.

B. Methodology & Parametrization

Given the distribution of labor and the matching technology, equation (18) alone determines the level of employment in each region. After noting that $n_k = L_{Ak} - U_{Ak} = L_{Bk} - U_{Bk}$, combining equations (20)-(22) yields two equations in w_{A1} and w_{A2}. By varying the distribution of labor, these solutions can be substituted into equation (19) to trace out Λ as a function of L_{A1} (= L_{B1}). From this point forward this curve will be referred to as the labor dynamics (LD) curve.

Table 4-1 lists the values of the parameters and the specific matching technology used to simulate the model.

Table 4-1: Simulation Parameters

s	r	γ	σ	β	$m(\cdot)$
.13	.04	.3	4	.75	$m(U_{Ak},U_{Bk})=C((.U_{Ak}\cdot U_{Bk})/(U_{Ak}+U_{Bk}))^{n}$

The inverse of the rate of worker separation is the implied rate of job tenure. The choice of s = .13 implies that the average job lasts around 7.7 years. This is approximately the average of the median tenure rates in the EU 15. The discount rate is chosen to be the approximate real rate of interest. The choice of $\gamma = .3$ implies that consumer's spend 30% of their incomes on differentiated products. Setting $\sigma = 4$ implies that firms' markup over marginal cost is 33%. The choice of β results in each firm producing exactly 1 unit of output. It can be easily verified that the matching technology in table 1 satisfies all of the assumptions in equation (10) if $C \leq 1$. Since in any possible steady state $U_{Ak} = U_{Bk}$ this function simplifies to $m(U_{Ak}) = C\ (U_{Ak})^n$. If the matching function exhibits constant returns to scale then $n = 1$ and the matching function is linear. If the matching technology exhibits increasing returns to scale then $n > 1$ and the function simplifies to $C(U_{Ak}/2)^n$.

III. Constant Returns to Scale in the Matching Technology

Under constant returns to scale the matching function is linear. Hence, $q_{jk} = C$ for all $j = \{A,B\}$ and $k = \{1,2\}$. Equation (17) then implies that $w_{Ak} = w_{Bk}$. The location variable, $\Lambda = \Lambda_1 = \Lambda_2$, now simplifies to the relative real wage

$$(25) \qquad \Lambda = \frac{w_{j1} / \Pi_1^{-\gamma}}{w_{j2} / \Pi_2^{-\gamma}}$$

A. Labor Dynamics

Before discussing the simulation results it is useful to note what would happen if trade costs were non-existent, i.e. $\tau = 1$. When there are no trade costs both the wage and the price of the differentiated good are the same in both locations. Otherwise, the product market will not clear. This can be confirmed by inspection of equation (22). In addition, this will be true no matter the degree of homogeneity that the matching function possesses. Hence, real wages are the same everywhere and the location variable is equal to unity for all distributions of labor. In this situation there is nothing to encourage or

discourage the population to deviate from its initial labor distribution. So, when there are no trade costs location doesn't matter and $\Lambda = 1$ for all potential steady state distributions of labor.

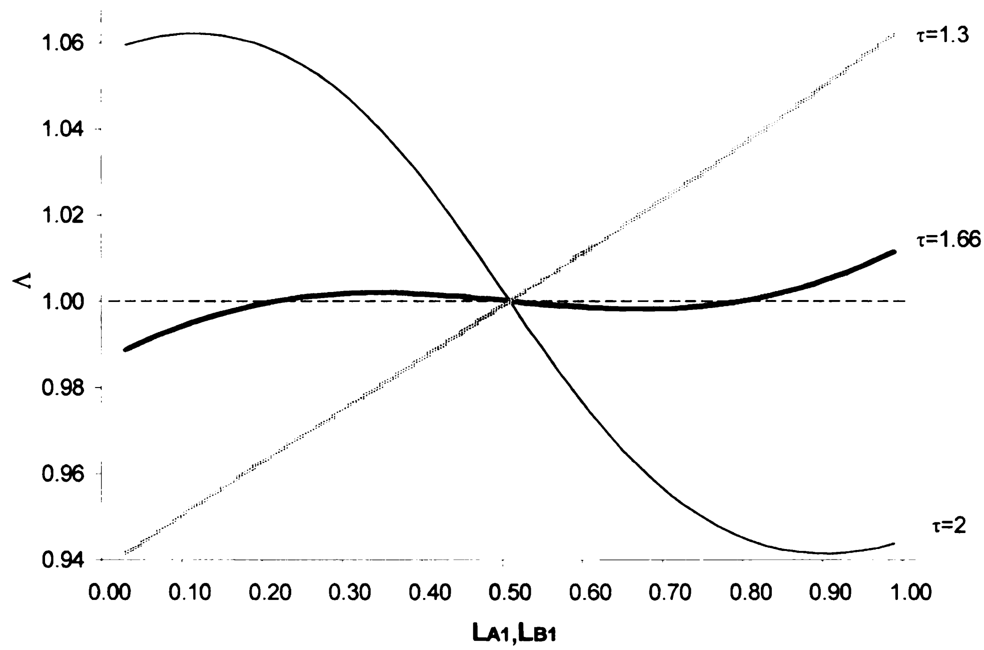

Figure 4-1: Labor Dynamics for CRS in the Matching Function and Symmetric Regions

Figure 4-1 depicts the LD curve for several different values of trade costs. When trade costs are high the location variable, Λ, exceeds unity when less than half of the population resides in region 1 and is less than unity when more than half of the labor force is located in region 1. Hence, the extent of competition dominates the price index and home market effects; and a symmetric equilibrium with an equal distribution of labor between regions is the only solution. Then, as trade costs fall to an intermediate level ($\tau = 1.66$) the LD curve begins to flatten out and there are then three classes of equilibria: a

symmetric equilibrium, two agglomerated equilibria where all manufacturing workers are located in a single region, and two non-symmetric equilibria where there is an uneven distribution of workers between regions. Since the LD curve is downward sloping in the neighborhood of the symmetric equilibrium it is stable. Hence, if the initial distribution of labor is close to symmetry the economy will end in a symmetric equilibrium. Since $\Lambda < 0$ in the neighborhood of $L_1 = 0$ and $\Lambda > 0$ in the neighborhood of $L_1 = 1$ the agglomerated equilibria are stable. So, if the initial distribution of labor is sufficiently asymmetric manufacturing will concentrate into a single region. Since the LD curve is upward sloping in the neighborhood of the asymmetric equilibria they are both unstable. So, for some labor distributions the price index and home market effects are dominated by the extent of competition and for others the reverse is true. The initial distribution of labor, then, will determine whether agglomeration occurs or not. Finally, as trade costs fall to a low level ($\tau = 1.33$) Λ is less than unity when less than half of the population resides in region 1 and is greater than unity when more than half of the labor force is located in region 1. Hence, the extent of competition is dominated by the price index and home market effects; and an agglomerated equilibrium is the only solution. Note that the region in which agglomeration occurs is determined entirely by the initial distribution of labor[3].

B. The Structure of Equilibria

To fully grasp the steady state labor dynamics of the model it is useful to look at the bifurcation diagram illustrated in figure 4-2, which shows the model's equilibria as a

[3] Note that if trade costs continue to fall the LD curve will eventually flatten out once again. For a detailed explanation see Fujita et al. (1999).

function of the level of trade costs. The thick lines represent stable equilibria and the thin lines represent unstable equilibria. When trade costs are very high the symmetric equilibrium is the only equilibrium that can be sustained. Then, as trade costs fall they reach a threshold level below which a concentrated equilibrium can be sustained in addition to the symmetric equilibrium.

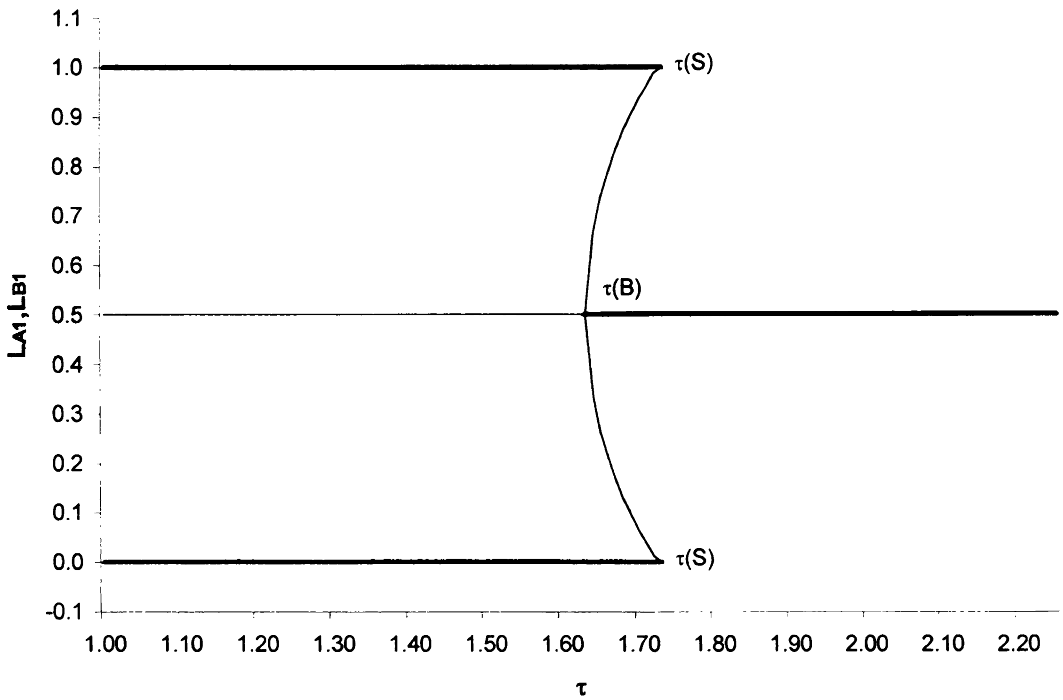

Figure 4-2: Bifurcation for CRS in the Matching Function and Symmetric Regions

Adhering to the terminology in Fujita et. al. (1999), this is called the sustain point and is labeled $\tau(S)$. Then, as trade costs fall yet further a second threshold level of trade costs is reached below which the symmetric equilibrium breaks down and agglomeration is the only sustainable equilibrium. This is called the break point and is labeled $\tau(B)$. Table 2 gives break and sustain points for several combinations of γ and σ.

Table 4-2: Break and Sustain Points for Various Parameter Values

	$\gamma = .3$		$\gamma = .5$		$\gamma = .7$	
	τ(B)	τ(S)	τ(B)	τ(S)	τ(B)	τ(S)
$\sigma = 4$	1.63	1.72	2.46	3.76	5.86	94.68
$\sigma = 6$	1.32	1.35	1.65	1.96	2.30	7.42
$\sigma = 8$	1.21	1.23	1.41	1.57	1.76	3.41

Note that as the share of manufactures in consumption, γ, grows so do the break and sustain points. Hence, a larger share of manufacturing in production will increase the range of trade costs for which agglomeration can be sustained. This is a result of a strengthening of the forward and backward linkages. A larger share of manufacturing in consumption will result in higher demand and, thus, higher wages (forward linkage); and a larger local market (backward linkage). In addition, a lower elasticity of substitution will also strengthen the forward and backward linkages resulting in a larger range of trade costs for which agglomeration can be sustained. A lower σ results in a greater degree of product differentiation which will result in greater price markups and, thus, wages (forward linkage); and a larger market (backward linkage).

The results above are identical to those that can be obtained in a full-employment world. This should not be an unanticipated result. The same forces that determine labor dynamics in the full-employment model are the forces that determine dynamics in the present model. Furthermore, since unemployment is a non-factor in the location decision under CRS it will not strengthen nor weaken any of these forces.

C. Unemployment

What effect will agglomeration have on economywide unemployment? Unemployment in each region is completely determined by the steady state equations (18A) and (18B). Hence, economywide unemployment can be determined by the sum of the unemployment levels determined by these equations. Proposition 2 establishes the impact that agglomeration has on this sum when the matching function exhibits constant returns to scale.

Proposition 2*: If the matching technology exhibits constant returns to scale the economywide unemployment rate is identical in all steady state equilibria.*

Proof: Equation (18) determines unemployment is each region. Totally differentiating this equation one can obtain $dU_{A1}/dL_{A1} = s/(s + dm(\cdot)/dU_{A1})$ and $dU_{A2}/dL_{A1} = -s/(s + dm(\cdot)/dU_{A2})$. Since $m(\cdot)$ exhibits constant returns to scale and is increasing $dm(\cdot)/dU_{Ak} = C$ where C is some positive constant[4]. Hence, $dm(\cdot)/dU_{A1} = dm(\cdot)/dU_{A2}$ which implies that $dU_{A1}/dL_{A1} + dU_{A2}/dL_{A1} = 0$. Thus, the reshuffling of labor between regions in any possible steady state results in no change in the number of unemployed workers in the economy. Q.E.D.

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[4] Note that this is not only true for the matching function listed in table 1, but for all increasing homogeneous of degree 1 functions with both arguments equal to one another.

The intuition here is straightforward. Constant returns to scale in the matching function implies that increasing (decreasing) the number of unemployed workers will increase (decrease) the number of matches proportionately. With a constant rate of separation this implies that a shift in the population will increase the number of unemployed workers in the target region by exactly the amount that the number of unemployed workers decreases in the source region. So, aggregate unemployment must be constant. Under CRS there is no employment benefit for the economy if agglomeration occurs.

IV. Increasing Returns to Scale in the Matching Technology

Under increasing returns to scale in the matching function the location variable does not simplify. The variables q_{jk} and q_{jr} are no longer equal to one another. Hence, the location variable is as given in equation (19).

A. Labor Dynamics

When increasing returns to scale in the matching function are introduced an additional force encouraging agglomeration arises. The rate at which an unemployed type j worker finds employment is increasing in L_{jk}[5]. So, there is a *job search effect* working in favor of agglomeration. Hence, the expected lifetime utility of searching in the larger region will tend to be higher than in the smaller region. So, one would expect that agglomeration will be an equilibrium for a larger range of parameters than in the CRS case. Once again, it is useful to note what would happen if trade costs were non-existent,

---

[5] Let E_{jk} be the number of employed type j workers in region k, then

$$\frac{dq_{jk}}{dL_{jk}} = \frac{d}{dL_{jk}}\left[C(1/2)^n (L_{jk} - E_{jk})^{n-1}\right] = C(1/2)^n (n-1)(L_{jk} - E_{jk})^{n-2} > 0.$$

i.e. $\tau = 1$. The results are identical to the CRS case. When there are no trade costs both the wage and the price of the differentiated good are the same in both locations. Otherwise, the product market will not clear. Hence, real wages are the same everywhere and the location variable is equal to unity for all distributions of labor. In this situation there is nothing to encourage or discourage the population to deviate from its initial labor distribution. So, when there are no trade costs location doesn't matter and $\Lambda = 1$ for all potential steady state distributions of labor.

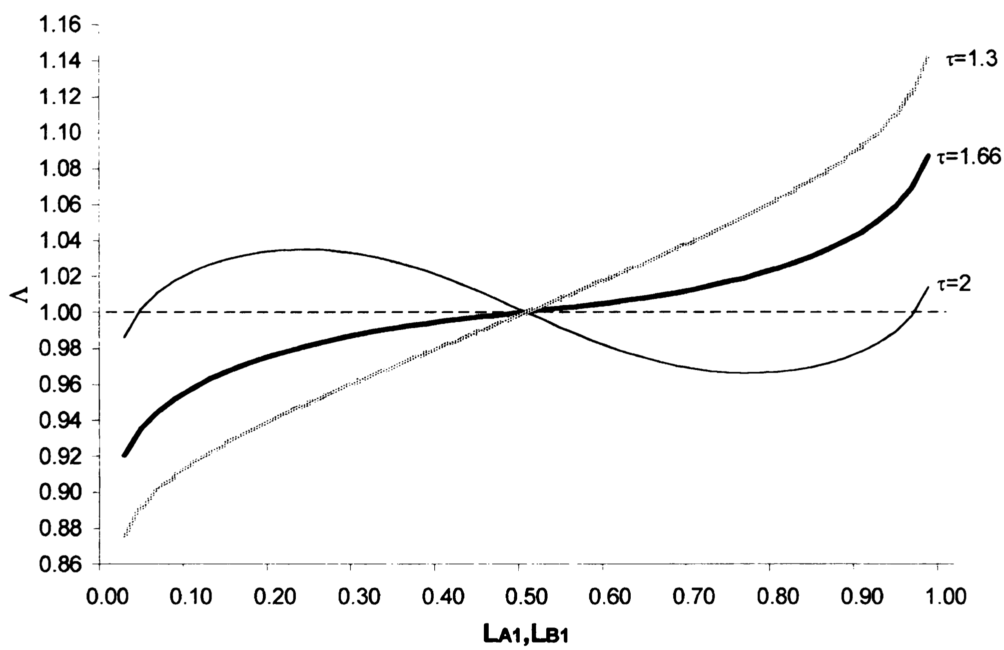

Figure 4-3: Labor Dynamics for IRS in the Matching Function and Symmetric Regions

Figure 4-3 depicts the LD curve for the three values of trade costs used in the CRS simulation. The matching function is identical to the previous simulations with the exception that n now takes the value 1.1. These curves have the same basic shapes as those generated in figure 4-1. However, the LD curves have flattened out somewhat.

When trade costs are high ($\tau = 2$) the picture is similar to the LD curve when there is an intermediate level of trade costs in the CRS case. Here, there are then three classes of equilibria: a symmetric equilibrium, two agglomerated equilibria, and two non-symmetric equilibria. Since the LD curve is downward sloping in the neighborhood of the symmetric equilibrium it is stable. Hence, if the initial distribution of labor is close to symmetry the economy will end in a symmetric equilibrium. Since $\Lambda < 0$ in the neighborhood of $L_1 = 0$ and $\Lambda > 0$ in the neighborhood of $L_1 = 1$ the agglomerated equilibria are stable. So, if the initial distribution of labor is sufficiently asymmetric manufacturing will concentrate into a single region. Since the LD curve is upward sloping in the neighborhood of the asymmetric equilibria they are both unstable. So, for some labor distributions the price index and home market effects are dominated by the extent of competition and for others the reverse is true. The initial distribution of labor, then, will determine whether agglomeration occurs or not. For both an intermediate level ($\tau = 1.66$) and a low level ($\tau = 1.33$) of trade costs Λ is less than unity when less than half of the population resides in region 1 and is greater than unity when more than half of the labor force is located in region 1. Hence, the extent of competition is dominated by the price index and home market effects; and an agglomerated equilibrium is the only solution. Note once again that the region in which agglomeration occurs is determined entirely by the initial distribution of labor.

B. The Structure of Equilibria

These results are made clearer when looking at the bifurcation diagram shown in figure 4-4, which, again, shows the model's equilibria as a function of the level of trade costs.

The thick lines represent stable equilibria and the thin lines represent unstable equilibria. When trade costs are very high there are three equilibria: a symmetric equilibrium and agglomeration in either region. This is true no matter how large trade costs are. Hence, the sustain point under increasing returns to scale is infinite as long as the degree of increasing returns is not minuscule[6]. As trade costs fall a threshold level is reached below which the symmetric equilibrium breaks down and agglomeration is the only sustainable equilibrium. This is the break point and is labeled $\tau(B)$. However, the break point is larger than when the matching function exhibits constant returns to scale.

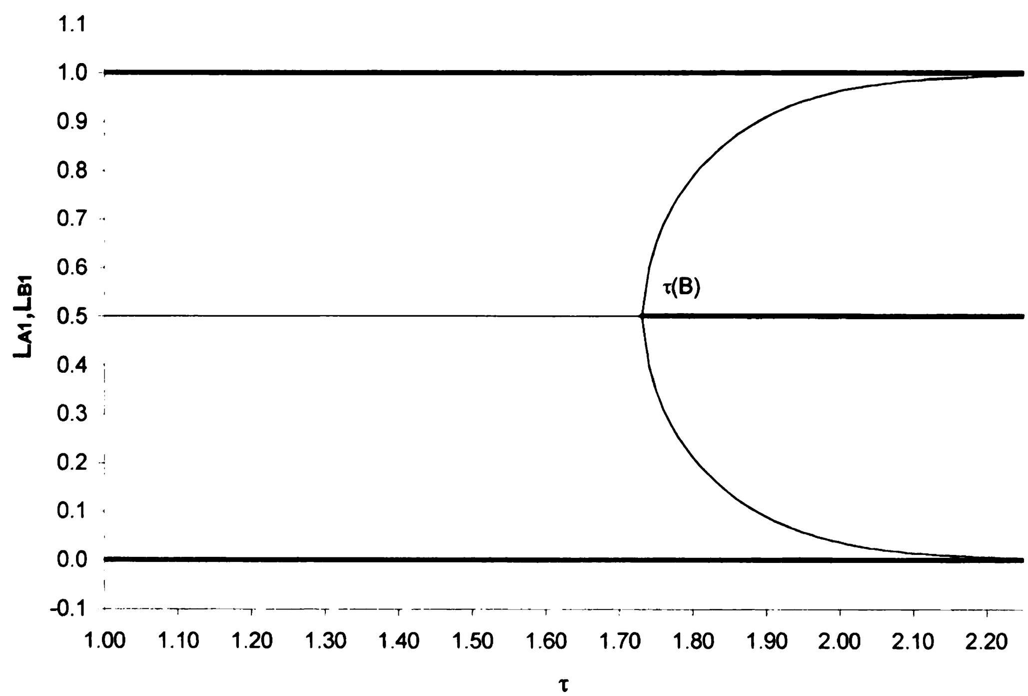

Figure 4-4: Bifurcation for IRS in the Matching Function and Symmetric Countries

[6] Infinite sustain points arise for values of n as small as 1.005.

Comparing these results to the constant returns case (or full-employment) it is clear that agglomeration is an equilibrium for a larger range of parameters when the matching function exhibits increasing returns. In fact, it is an equilibrium for all parameter values if the initial distribution of labor is sufficiently asymmetric. In addition, it is the *only* equilibrium for a larger range of parameters than the CRS case evidenced by the larger break point. In fact, as the degree of homogeneity in the matching function increases the job search effect gets stronger which will increase the break point. This result is summarized in table 4-3 which shows the break point for various degrees of homogeneity in the matching function.

Table 4-3: Break Points for Varying Degrees of Homogeneity in the Matching Function

n	1	1.1	1.2	1.3	1.4	1.5	2
τ(B)	1.64	1.74	1.85	1.96	2.07	2.18	2.76

The intuition behind these results is clear. In the CRS case when workers migrate from one region to the other there is a proportional increase in the number of varieties produced and then wages adjust according to the home market effect, the price index effect, and the extent of competition. This is also what happens in a full-employment world. A shift in the labor force results in a proportional increase in the number of products produced since the unemployment rate is the same for all distributions of labor. However, with increasing returns to scale there is a more than proportional increase in the number of products produced due to the job search effect since the unemployment rate is lower in the larger region.

D. Labor Market Efficiency

Partial equilibrium models of search based unemployment show that inefficiencies exist in the labor market due to externalities that arise during the matching process. Since the product market does not affect employment and, thus, has no impact on the matching process these inefficiencies are identical to those found in the present model. The reason for these externalities is that when a match occurs the expected lifetime utility increases for both parties. However, a worker will ignore the increase in her partner's expected income. This neglect will cause the unemployment rate to be either too high or too low depending on the properties of the matching function.

The one situation where the labor market is efficient is when both parties contribute equally to the matching process and the matching function exhibits constant returns to scale. Since the matching function given in table 1 is symmetric and $L_{Ak} = L_{Bk}$ in any potential steady state equilibrium, when the matching function exhibits constant returns to scale the labor market will generate an efficient outcome. This is not the case under increasing returns in the matching function where the unemployment rate is too low since workers have higher marginal products compared to incomes[7].

[7] For a detailed analysis of these externalities see Diamond (1982).

C. Unemployment

How will agglomeration affect economywide unemployment when the matching function exhibits increasing returns to scale? The answer to this question has already been alluded to. However, proposition 3 establishes the results formally.

***Proposition 3**: If the matching technology exhibits increasing returns to scale the steady state economywide unemployment rate is non-increasing in regional agglomeration.*

Proof: Suppose that there are an equal number of workers in each region ($L_{A1} = .5$). Then, $U_{A1} = U_{A2}$ which implies $dm(\cdot)/dU_{A1} = dm(\cdot)/dU_{A2}$. Hence, $dU_{A1}/dL_{A1} + dU_{A2}/dL_{A1} = 0$[8] meaning that a very small change from a symmetric equilibrium does not affect the unemployment rate. Now suppose that one of the regions is larger than the other. Without loss of generality, suppose that $L_{A1} > .5$. Then, $U_{A1} > U_{A2}$. Since $m(\cdot)$ is homogeneous of degree k and increasing $dm(\cdot)/dU_{Ak}$ is an increasing function of U_{Ak}. Hence, $dm(\cdot)/dU_{A1} > dm(\cdot)/dU_{A2}$ which implies that $dU_{A1}/dL_{A1} + dU_{A2}/dL_{A1} < 0$. Thus, making the larger region even larger will decrease the number of unemployed workers in the economy. Q.E.D.

Again, the intuition is straightforward. Increasing returns to scale in the matching technology implies that increasing (decreasing) the number of unemployed workers will increase (decrease) the number of matches more than proportionately. This implies that a shift in the population will increase the number of unemployed workers in the target region by less than the amount that the number of unemployed workers decreases in the

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[8] Expressions for these derivatives are given in the proof of proposition 2.

source region. So, aggregate unemployment is decreasing in regional concentration. Under increasing returns to scale there is a positive employment benefit to regional agglomeration.

V. Regional Asymmetry

The analysis now turns to the situation where the separation rate differs between regions. Why might this parameter vary between regions that are otherwise identical? First, as Shapiro-Stiglitz (1984) note, the breakup rate is ultimately linked to the employment package offered by firms. In the model presented here the package includes only the wage. However, in the real world this may include any number of benefits such as health insurance, vacation time, and so on, which are absent from the present analysis. Suppose that these services are simply available for employees to use at no additional labor cost. Then, it is plausible that the level of these services will differ between regions based on history. Furthermore, reactions of the public sector to unemployment may also differ from location to location especially if local governments are permitted to determine their own policy[9].

A. Labor Dynamics with Asymmetrical Separation and CRS in the Matching Technology

Suppose that the separation rate is lower in region one than in region two. Then, the location variable is given by[10]

$$(25) \qquad \Lambda = \left(\frac{w_{j1} / \Pi_1^{\gamma}}{w_{j2} / \Pi_2^{\gamma}} \right) \left(\frac{r + s_2 + 1}{r + s_1 + 1} \right)$$

---

[9] This is certainly the case in the EU where each country decides its own public policy as well as in the U.S. where policies often vary from state to state.

[10] Recall that $q_{jk} = 1$ for all j and all k when the matching function exhibits CRS.

The figures that follow were derived with $s_1 = .11$, $s_2 = .15$, and all other parameters as listed in table 4-1 when the matching function exhibits constant returns to scale. Again, it is useful to note what would happen if trade costs were absent. The results are very different from the symmetric case. Just as before, both the wage and the price of the differentiated good are the same in both locations. Otherwise, the product market will not clear. Hence, real wages are the same everywhere. However, since $s_1 < s_2$ equation (25) suggests that in the absence of trade costs unemployed workers will always want to migrate into region 1 where the separation rate is lowest. This additional pull into region one occurs because the separation rate is ultimately linked to tenure: lower rates of job separation mean longer tenure. So, the expected lifetime utility of working in region one will exceed that of region two even if wages are prices are identical everywhere. Hence, this will be referred to as the *tenure effect*.

Figure 4-5 shows the analog of figure 4-1 when the separation rates are asymmetric. The shapes of the curves are similar to the symmetric case. However, the structure of equilibria is a bit different. When trade costs are high ($\tau = 2$) there is one stable equilibrium, and when trade costs are low there are two stable equilibria with agglomeration in either region. These are also what result in the symmetric case. However, at an intermediate value of trade costs value of every point on the LD curve exceeds unity. Hence, agglomeration into region one is the only equilibrium.

It is useful to examine these results more carefully. First note that the *symmetric* equilibrium, as in figure 4-1, is no longer symmetric. That is, there is no equilibrium where $L_1 = .5$. When trade costs are high the only stable equilibrium has slightly more than half of the workforce locating in region 1 where the separation rate is lower. This is

a logical result considering that the lower separation rate tends to draw more workers into region one.

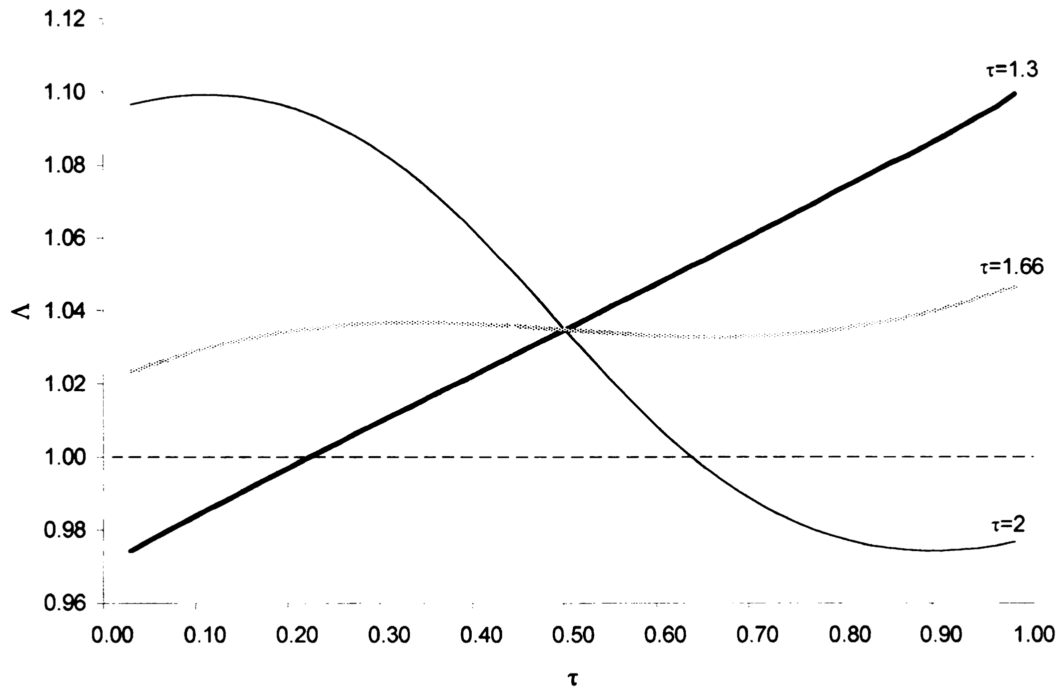

Figure 4-5: Labor Dynamics for CRS in the Matching Function and Asymmetric Regions

When trade costs are low the unstable equilibrium has less than half the workforce locating in region one and any deviation from this equilibrium will shoot the economy into an agglomerated equilibrium in one region or the other. This, again, is a logical result when the lower separation rate in region one is taken into account. If the economy begins at a random distribution of labor it will be more likely that the economy agglomerates into the region with lower rate of separation than in the region with the higher rate of separation. Finally, when trade costs take on an intermediate value the only equilibrium is agglomeration into region one. This occurs since the extra pull of workers into region one prevents any equilibria where a larger proportion of the labor force is located in region two until trade costs fall significantly lower than in the symmetric case. So, for all values of trade costs the forces driving the labor dynamics of the model make it more likely that the economy have a larger proportion of the workforce located where the expected length of tenure is longer.

To fully grasp the structure of equilibria it is again useful to look at the bifurcation diagram, figure 4-6, which shows the equilibria of the model as a function of trade costs. The solid lines represent stable equilibria and the thin lines represent unstable equilibria.

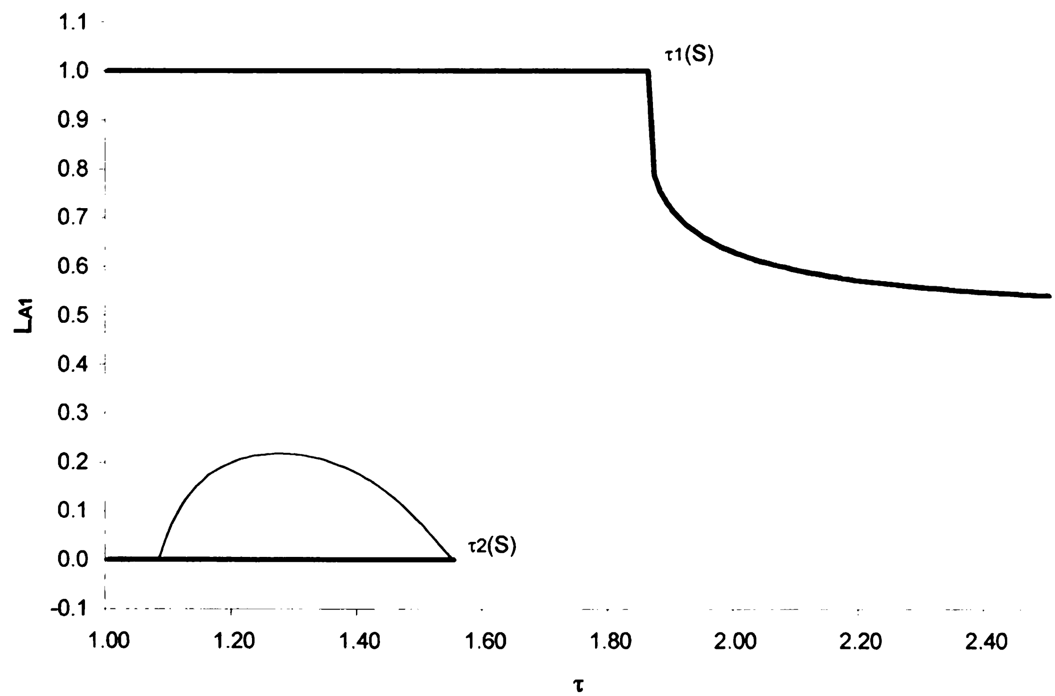

Figure 4-6: Bifurcation for CRS in the Matching Function and Asymmetric Regions

As transportation costs fall, the LD curve begins to flatten out pushing the stable equilibrium further and further towards concentration into region one. Then, as transport costs fall further to the region one sustain point, $\tau_1(S)$, concentration in region 1 is the

only solution. As transport costs fall yet further to the region 2 sustain point, $\tau_2(S)$, the LD curve becomes upward sloping and concentration in either region can be sustained. Note that unless the initial distribution of labor is highly skewed with more workers in region 2 as trade costs fall over time the economy will naturally agglomerate itself into region 1.

B. Unemployment with Asymmetric Separation and CRS in the Matching Technology

How will the asymmetries discussed above affect the economy's aggregate unemployment rate? With asymmetric separation, the equation that defines the unemployment rate is different in each region is

(26A) $m(U_{Ak}, U_{Bk}) = (L_{Ak} - U_{Ak})s_1$

(26B) $m(U_{Ak}, U_{Bk}) = (L_{Bk} - U_{Bk})s_2$

Proposition 4 establishes the effects of labor migration when labor markets are asymmetric and the matching function exhibits constant returns to scale.

Proposition 4: *If $s_1 < s_2$ and the matching function exhibits constant returns to scale the economywide unemployment rate is decreasing in L_{A1} (= L_{B1}).*

Proof: Equation (25) determines unemployment is each region. Totally differentiating this equation one can obtain $dU_{A1}/dL_{A1} = s_1/(s_1 + dm(\cdot)/dU_{A1})$ and $dU_{A2}/dL_{A1} = -s_2/(s_2 + dm(\cdot)/dU_{A2})$. Since $m(\cdot)$ exhibits constant returns to scale and is increasing, $dm(\cdot)/dU_{Ak}$ = C where C is some positive constant. Hence, $dm(\cdot)/dU_{A1} = dm(\cdot)/dU_{A2} = C$. Then, $dU_{A1}/dL_{A1} + dU_{A2}/dL_{A1} = s_1/(s_1 + C) - s_2/(s_2 + C) = (s_1 - s_2)C/(s_1 + C)(s_2 + C) < 0$.

Q.E.D.

Hence, as workers move into the region with the lower separation rate the aggregate unemployment rate falls. The intuition here is straightforward. When a contingent of the population moves into region 1 the lower separation rate there implies that fewer of these workers will remain unemployed causing a reduction in economywide unemployment.

C. Labor Dynamics with Asymmetrical Separation and IRS in the Matching Technology

How will these results change if the matching function exhibits increasing returns to scale? The location variable is now given by

$$(27) \qquad \Lambda_j = \left(\frac{\Pi_1}{\Pi_2}\right)^{-\gamma}\left(\frac{w_{j1}}{w_{j2}}\right)\left(\frac{q_{j1}(U_{A1},U_{B1})}{q_{j2}(U_{A2},U_{B2})}\right)\left(\frac{r+s_2+q_{j2}(U_{A2},U_{B2})}{r+s_1+q_{j1}(U_{A1},U_{B1})}\right)$$

Hence, the job search effect discussed above now comes into play. One would then expect that, as in the symmetric case, agglomeration is an equilibrium for a larger range of parameters when the matching function exhibits IRS than when it exhibits CRS. Again, it is useful to note what would happen if trade costs were absent. Just as with the CRS case, both the wage and the price of the differentiated good are the same in both locations. Otherwise, the product market will not clear. Hence, real wages are the same everywhere. However, the job search effect suggests that in the absence of trade costs unemployed workers will always want to migrate into region 1 where the separation rate is lowest. So, if there are no trade costs workers will agglomerate into region 1.

Figure 4-7 shows the LD curve for both high and low trade costs. The shapes of the two curves are similar to the CRS case, however the structure of equilibria is quite different. When trade costs are high ($\tau = 2.1$) there are four equilibria: agglomeration in each region, and two non-symmetric equilibria one with a larger concentration of manufactures than the other. The two agglomerated equilibria as well as the non-symmetric equilibrium with the smaller concentration of manufacturing workers are stable. The remaining equilibrium is unstable. So, once again when trade costs are high agglomeration can be sustained if the initial distribution of labor is sufficiently asymmetric (in this case very asymmetric). Otherwise, the economy will end up with more than half but not all of its manufacturing labor in region 1. This is a sensible result since that the lower separation rate tends to draw more workers into region one and the job search effect tends to draw workers into the larger region.

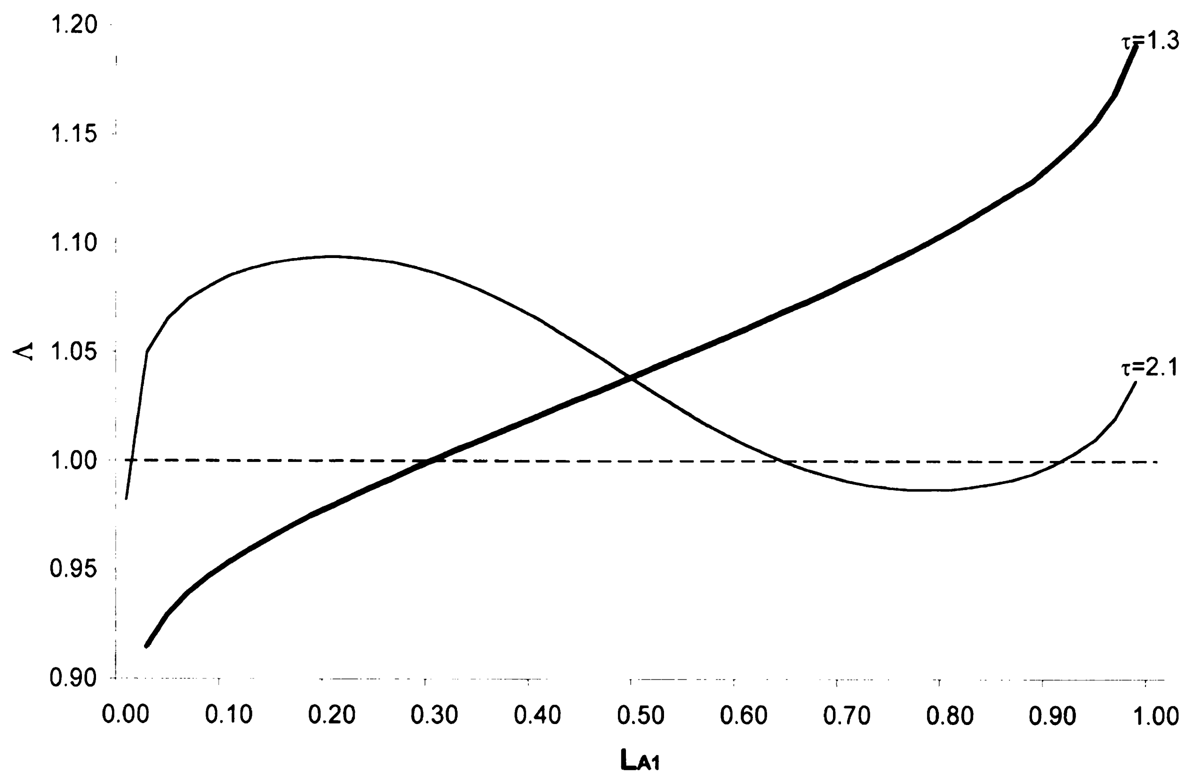

Figure 4-7: Labor Dynamics for IRS in the Matching Function and Asymmetric Regions

When trade costs are low ($\tau = 1.33$) the unstable equilibrium has less than half the workforce locating in region one and any deviation from this equilibrium will shoot the economy into an agglomerated equilibrium in one region or the other. This is a sensible result when the lower separation rate in region one and the job search effect are taken into account. If the economy begins at a random distribution of labor it will be more likely that the economy agglomerates into the region with lower rate of separation than in the region with the higher rate of separation.

To fully grasp the structure of equilibria it is again useful to look at the bifurcation diagram, figure 4-8, which shows the equilibria of the model as a function of trade costs.

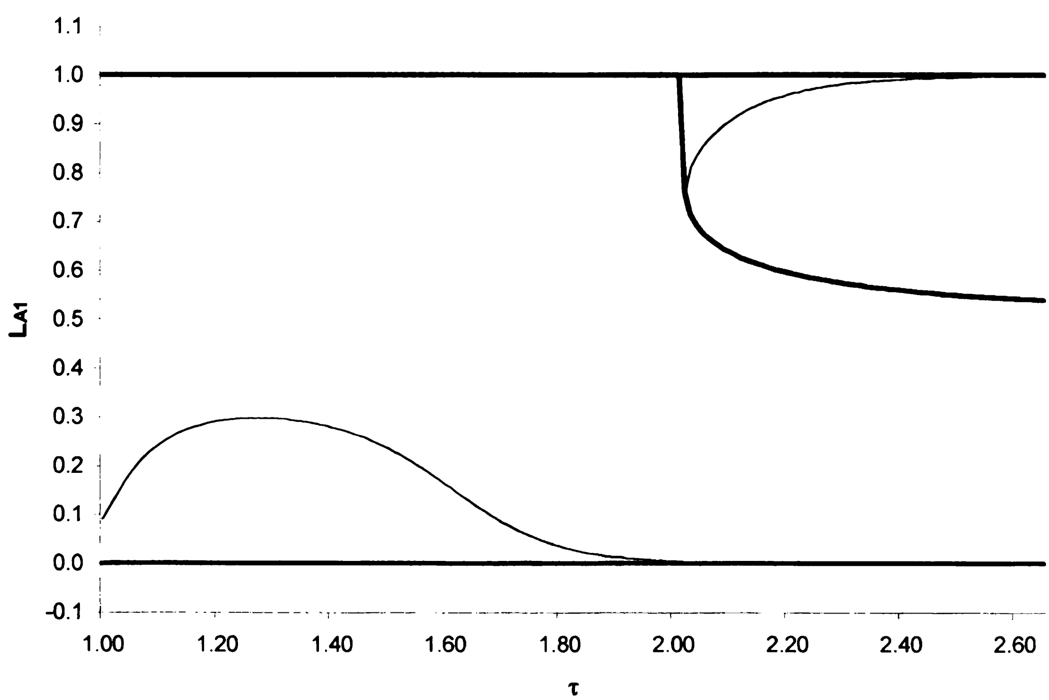

Figure 4-8: Bifurcation for IRS in the Matching Function and Asymmetric Regions

The solid lines represent stable equilibria and the thin lines represent unstable equilibria. Just as with CRS in the matching technology the sustain points are infinite. Hence, for any parameter values agglomeration into either region can always be sustained. As trade costs fall, the LD curve begins to flatten out pushing the stable equilibrium further and further towards concentration into region one until the only stable equilibria are concentration in either region. Note once again that unless the initial distribution of labor is highly skewed with more workers in region 2 as trade costs fall over time the economy will naturally agglomerate into region 1.

D. *Unemployment with Asymmetric Separation and IRS in the Matching Technology*

How will the asymmetries discussed above affect the economy's aggregate unemployment rate? Proposition 5 establishes the effects of labor migration when labor markets are asymmetric and the matching function exhibits increasing returns to scale.

***Proposition 5**: If $s_1 < s_2$ and the matching function exhibits increasing returns to scale the economywide unemployment rate is decreasing in L_{A1} (= L_{B1}).*

Proof: Suppose that there are an equal number of workers in each region ($L_{A1} = .5$). Then, $U_{A1} = U_{A2}$ which implies $dm(\cdot)/dU_{A1} = dm(\cdot)/dU_{A2}$. Hence, $dU_{A1}/dL_{A1} + dU_{A2}/dL_{A1} < 0$ just as when the matching function exhibits CRS. Now suppose that $L_{A1} > .5$. Then, $U_{A1} > U_{A2}$. Since $m(\cdot)$ is homogeneous of degree k and increasing, $C_k = dm(\cdot)/dU_{Ak}$[11] is an increasing function of U_{Ak}. Hence, $C_1 > C_2$. Then $dU_{A1}/dL_{A1} + dU_{A2}/dL_{A1} = s_1/(s_1 + C_1) - s_2/(s_2 + C_2) = s_1C_1 - s_2C_2/(s_1 + C_1)(s_2 + C_2) < C_1(s1 - s2)/(s_1 +$

[11] Note that C_k is not a constant. This notation is used convenience.

$C_1)(s_2 + C_2) < 0$. Now suppose that $L_{A1} < .5$. Then, $C_1 < C_2$. So, $dU_{A1}/dL_{A1} + dU_{A2}/dL_{A1} = s_1/(s_1 + C_1) - s_2/(s_2 + C_2) = s_1C_1 - s_2C_2/(s_1 + C_1)(s_2 + C_2) < s_2(C_1 - C_2)/(s_1 + C_1)(s_2 + C_2) < 0$. Q.E.D.

Thus, for any distribution of labor moving workers into region one will decrease unemployment. The intuition here is somewhat similar to the constant returns case. When a contingent of the population moves into region 1 the lower separation rate there implies that fewer of these workers will remain unemployed causing a reduction in economywide unemployment. However, as region 1 grows in population the number of matches rises causing unemployment to fall even further. So, one would expect that unemployment would be lower in an agglomeration when the matching function exhibits increasing returns versus when the matching function exhibits constant returns.

VI. Conclusions

The analysis above has shown that when labor market search frictions are added to a new geography model the results depend entirely on the returns to scale of the matching technology. With a CRS matching function labor dynamics are identical to the full-employment model and economywide unemployment is unchanged by shifts in the distribution of the population. With an IRS matching function unemployment decreases as the population concentrates into a single region. Thus, agglomeration becomes more likely due to this employment effect that, in turn, makes the price index effect stronger.

It is also shown that under constant returns to scale in the matching technology no matter the distribution of labor the unemployment rate is constant. So there is no employment benefit to agglomeration. However, if the matching function exhibits increasing returns to scale employment rises as a region increases in size. Hence, agglomeration will result in a decline in economywide unemployment.

Finally, it is shown that allowing for asymmetric separation rates between regions will alter the labor dynamics by making it more likely that the region with the lower rate of separation receives the agglomeration. Furthermore, it is shown that agglomerating into the region with the lower rate of separation will, no matter the degree of homogeneity in the matching function, increase employment.

Chapter 5:

Concluding Remarks

The preceding chapters have presented three models which examine both the relationship between the falling costs of trade and unemployment; and the role that regional (or national) labor market characteristics, in particular rates of tenure, have in determining patterns of industrial agglomeration. There are a several general conclusions one can draw from these three models. First, when industry agglomerates into industrial regions as a result of falling trade costs unemployment rates will be at least as low as when industry does not agglomerate in "core", industrialized regions. So, one can conclude that, at least in this framework, globalization has at best a positive impact and at worst no impact on employment in developed nations. This allays at least some of the fear that globalization will cause workers in developed countries to lose out from low-wage competition in the less developed world. Second, in the short term unemployment will increase in "peripheral", less developed regions, but in the long term unemployment rates will converge to those of the developed world. Globalization forces less developed countries to suffer short term costs that they would have otherwise incurred. However, they can reap long term benefits. One question that remains unresolved is whether the long term gains outweigh the short term costs. Third, differences in regional labor market characteristics do affect agglomeration patterns: agglomeration is more likely to occur in regions (or countries) where tenure is long relative to other regions. This reveals an oversight in much of the new geography literature that ignores individual regional characteristics. While a core-periphery pattern does still emerge, it may be possible to determine which regions are most likely to receive agglomerations based on factors other than population size.

It is important to note some limitations of this analysis. First, admittedly, these models present a very specific framework. There are specific utility and production functions in all three models. So, overly general conclusions may be a bit of a reach. However, understanding the forces at work in these models can give some insight into how at least a piece of the economy operates. So, while these models suggest that globalization will have a positive impact on employment in the developed world it does not mean that other forces absent from the model will not counteract them I the real world. Second, in all three models the assumption that agriculture can be traded at no cost is made. This is akin to assuming that trade costs on differentiated goods are higher than trade costs on homogeneous goods. If this assumption is taken away the results of these models will change dramatically. If trade costs on homogeneous goods are small then the range of parameters for which agglomeration can be sustained will shrink. But, if trade costs on homogeneous goods are high enough agglomerations will disappear altogether[1]. So, there is the question of whether trade costs, in reality, are higher for differentiated or homogeneous goods. Rausch (1999) shows that traditional measures of trade costs are higher for homogeneous goods. He also suggests that non-traditional measures (e.g. non-tariff barriers) are also higher for homogeneous goods. However, he admits that his methods of measuring non-traditional costs are far from ideal. Many economists have suggested that non-tariff barriers are much higher for differentiated goods. Hence, it is not clear whether the total costs of trade are higher for homogeneous goods or differentiated goods. This is a topic that warrants further empirical analysis.

[1] For a detailed analysis of this issue see Davis (1998) and Fujita, et. al (1999).

There are several directions in which this research can progress. First, this framework could be extended to multiple countries where blocks of countries are be permitted to form trading alliances so that it is cheaper to trade with a member than with a non-member. What sorts of unemployment patterns would emerge from such a model? Could the less developed countries gain by forming trading agreements with one another? With developed countries? Second, can other regional characteristics affect agglomeration patterns in ways similar to labor market characteristics? Of particular interest is whether policy can attract firms into a region giving rise to agglomeration forces. Ludema and Wooton (2000) have shown that this in fact is the case in a model of tax competition. Since unemployment is often a concern in attracting firms the framework developed here would seem ideal to study such problems. Third, the fact that labor market asymmetries have an affect on location size is a testable hypothesis. So, it would be useful to integrate such asymmetries into any empirical model attempting to test the viability of the new geography framework.

APPENDIX

Proposition: In any steady state equilibrium $h_k^M = h_k^A$.

Proof of Proposition 1: In any steady state equilibrium, by definition, the expected lifetime utility of an unemployed worker in the manufacturing sector must be identical to the expected lifetime utility of an unemployed worker in the agricultural sector. First, an expression for V_k^{ur} for r = {M,A} must be attained. Rearranging equations (14) and (15)

$$\text{(A1)} \quad V_k^{nr} = \frac{\Gamma w_k \Pi_k^{-\gamma} - e + b_k V_k^{ur}}{\rho + b_k}$$

$$\text{(A2)} \quad V_k^{sr} = \frac{\Gamma w_k \Pi_k^{-\gamma} + (b_k + q_k) V_k^{ur}}{\rho + b_k + q_k}$$

Then, setting $V_k^{nr} \geq V_k^{sr}$ to assure that the NSC is satisfied gives

$$\text{(A3)} \quad \Gamma w_k \Pi_k^{-\gamma} \geq \frac{e}{q_k}\left[\rho + b_k + q_k\right] + \rho V_k^{ur}$$

Subtracting equation (13) from equation (14)

$$\text{(A4)} \quad \rho\left(V_k^{nr} - V_k^{ur}\right) = \Gamma w_k \Pi_k^{-\gamma} - e - \left(h_k^r + b_k\right)\left(V_k^{nr} - V_k^{ur}\right)$$

Solving for $\left(V_k^{nr} - V_k^{ur}\right)$ and substituting this into equation (13)

$$\text{(A5)} \quad V_k^{ur} = \frac{\left(\Gamma w_k \Pi_k^{-\gamma} - e\right) h_k^r}{\left(\rho + b_k + h_k\right)\rho}$$

Since the NSC must be satisfied in any equilibrium, rearranging equation (16) gives

$$\text{(A6)} \quad \Gamma w_k \Pi_k^{-\gamma} - e = \frac{e}{q}\left(\rho + b + h_k^r\right)$$

Substituting this into (A5) gives

$$\text{(A7)} \quad V_k^{ur} = \frac{e}{\rho q} h_k^r$$

In steady state equilibrium $V_k^{uM} = V_k^{uA}$. It is evident from equation (A7) that this can be true only if $h_k^M = h_k^A$. Q.E.D.

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