This is to certify that the

dissertation entitled

Essays on Economic Development and Institutions

presented by

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has been accepted towards fulfillment
of the requirements for

Ph.D. degree in Economics

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Date November 13, 2000

ESSAYS IN ECONOMIC DEVELOPMENT AND INSTITUTIONS

By

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A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

Department of Economics

2000

ABSTRACT

ESSAYS IN ECONOMIC DEVELOPMENT AND INSTITUTIONS

By

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Recent economic literature has suggested that institutional elements like corruption, bureaucratic inefficiency, and monopolistic industries constitute an important restraint for the economic development of poor nations. My dissertation analyses the macroeconomic impact of some of these elements. First, it studies the effects of corruption and bureaucratic regulations on both the creation and the distribution of wealth. Second, motivated by the recent developments in several energy and telecommunication markets, it studies the benefits of privatization and deregulation of intermediate industries that have been traditionally controlled by public monopolies.

The first chapter of my dissertation, "Corruption and Growth: Theory and Evidence" analyzes the effects of corruption on the rate of income growth. Using a dynamic general equilibrium model in which private investors are able to bribe corrupt public officials in order to circumvent a set of government regulations, the model shows that the growth-maximizing level of corruption can be greater than zero. This result is then corroborated by an empirical analysis of the relationship between the ICRG corruption index and the rate of GDP growth for a cross section of countries following the growth accounting literature. The empirical findings remain robust under several specifications, including regressions in first differences and a Granger causality test.

The second chapter, "Regulations, Corruption and Income Distribution", develops a variant of the overlapping generations model in which the investors face costly bureaucratic regulations that can be avoided by paying a bribe. Here, the individuals are endowed with a different amount of effective labor according to a probability function and the rents from corruption are determined by an exogenous parameter that varies how unequal the allocation of these rents is. After solving the model and running computational simulations, the model suggests that the combination of cumbersome regulations and widespread corruption increase income inequality. Furthermore, the model points to the distribution of corruption rents as the most important channel through which corruption affects the overall income distribution and highlights the role of government regulations in determining the level of corruption.

The third chapter, "Privatization, Deregulation and Capital Accumulation" presents a model of capital accumulation with one consumption good and an intermediate good used in the production of final goods only. The model is solved under three alternative scenarios: one where the intermediate sector is composed of a public monopoly under government control, one where the intermediate sector is dominated by a private monopoly, and one with a competitive intermediate sector. The comparison of these models suggests that the income benefits of state-to-market transitions are mostly due to increased competition in the deregulated market and that the privatization of state enterprises alone is not likely to generate significant changes in the economy. In fact, the model predicts that for high enough levels of public investment, a public monopoly would be preferred to a private monopoly in terms of the resulting aggregate income level.

Dedicada a mis Padres.

ACKNOWLEDGMENTS

Throughout all the hours of work my wife provided an almost unbelievable amount of emotional, spiritual and philosophical support. It was her who listened to all the crazy ideas, emotional speeches and broken-hearted monologues that came along my doctorate with unbounded love, sincere interest and inevitable patience. Thank you AnneLyse for all the efforts you made, they were not for granted.

I am forever indebted with Gerhard Glomm and Rowena Pecchenino, who taught me economics and guided me through the completion of this dissertation. I am also thankful to Paul Strassmann for his numerous advices and for all the housing conversations that he granted me. I am honored to call myself their student and their friend.

In a similar way, I want to give special thanks to Jeffrey Wooldridge and Pierfederico Asdrubali for their comments and dedication. I also want to thank Facundo Sepulveda with whom I shared long hours of work and to Daiji Kawaguchi, Tom Davis, Stephan Krause, Francisco Alpizar, Frederic Derusseau, Paul Corrigan, Douglas Harris, Alina Luca, Iva Pestova and other fellow students who also helped with their comments.

Finally, I must recognize the important contribution in all facets of life that I received from my friends here in East Lansing. Sin Juan Carlos "papito", los "settlers" con el Matías, Christian y el "Bena", los asados donde los Queijo, las vivencias de Luis, el basket con Miguel y Sergio, los serbios, todos los ticos de Michigan, los regalitos de Johnny, y los aportes de tantos personajes inolvidables, nada hubiese sido lo mismo…

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CHAPTER 1

CORRUPTION AND GROWTH: THEORY AND EVIDENCE

1. Introduction

Over the last few years, economists have begun to study how the institutional framework of societies affects economic growth[1]. Within this literature, the issue of corruption has captured a great deal of attention. The 1997 World Bank's World Development Report, for example, stated that without an honest state "sustainable development, both economic and social, is impossible". Similarly, Gray and Kaufmann (1998) reported a recent survey in which high-ranking officials from more than 60 developing countries classified corruption as "the most severe impediment to development and growth".

The theoretical literature on this matter has generated a rich debate for the last thirty years. On one hand, people like Krueger (1974), Myrdal (1989), Shleifer and Vishny (1993), Tanzi (1997), and Mauro (1995,1998) have argued that corruption is detrimental to economic growth. They point out that corruption modifies the goals of the government and creates a diversion of resources from public purposes to private ones, therefore, resulting in a deadweight loss to society[2]. Furthermore, governmental corruption may also discourage private investment by raising the cost of public administration (since it is likely to take the form of a bribe for a public service) or by

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[1] See for example North (1993), Keefer and Knack (1997), Sachs and Warner(1997)

[2] In a related argument Krueger (1974) explains how unproductive, "rent-seeking" activities can be expected to arise in a corrupt environment.

generating social discontent and political unrest, which in turn, may slow down economic growth (Alesina (1992)).

At the same time, authors like Leff (1964), Huntington (1968), Friedrich (1972) and Nye (1989) have suggested that it is also possible for corruption to be beneficial for economic growth. They argue that, if the government has produced a package of pervasive and inefficient regulations, then, corruption may help circumvent these regulations at a low cost. Under this scenario, it is plausible that corruption may improve the efficiency of the system and actually help economic growth[3].

In many developing countries, cumbersome government regulation is pervasive. In Mexico, for example, the problem became so evident that in 1988 the president appointed a "deregulation czar". Under this system the "czar" would have to amend any regulation that had been questioned by private agents in less than 45 days after the initial complaint; otherwise, the regulation would be automatically eliminated[4].

Another argument in favor of corruption has viewed bribery as "speed money"; that is, as payments that speed up the bureaucratic process, or payments that are intended to "mediate" between political parties that would not reach an agreement otherwise. Then, as long as the time consumed by administrative procedures is reduced by the bribe, the bribers could be made better off. Lui (1985), for example, presents a model in which the costs of "standing in line" are minimized by the use of bribes. Kaufmann and Wey (1998), however, contest the empirical validity of this hypothesis.

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[3] In a famous passage Huntington (p.69) states it simply: "In terms of economic growth, the only thing worse than a society with a rigid, over centralized, dishonest bureaucracy is one with a rigid, over centralized, honest bureaucracy".
[4] See the World Bank's World Development Report (1997) for more detail.

In contrast, the empirical literature in the field has consistently reported a negative correlation between economic growth and the level of corruption, and the evidence for beneficial effects has been scarce at best[5]. Using a cross section of countries, Mauro (1995) demonstrated that after controlling for a number of economic and sociopolitical factors, the relationship between corruption and economic growth is negative. Keefer and Knack (1997) also reported a negative correlation between corruption and GDP growth. Others like Hall and Jones (1999) and Sachs and Warner (1997) obtained similar results.

Thus, most of the empirical evidence seems to be consistent with the theories that hold corruption as purely detrimental. However, all these empirical studies assume that corruption has only a monotonic impact upon growth, and therefore, provide an incomplete test of the hypothesis that have treated this impact as a differentiated phenomenon depending on the size of corruption. Neither the theoretical model nor the empirical work presented in this paper use such assumptions and allow the effects of corruption to vary as the size of corruption changes.

Our modeling strategy is motivated by the results of a 1997 World Bank survey "Obstacles for Doing Business" (see Brunnetti, Kisunko and Weder (1998)). The Survey was conducted in 72 countries and asked firm managers to rate the relative importance of different obstacles for the normal operation of their projects. The results of the survey reveal corruption and tax regulations as the worst obstacles for doing businesses. The level of these regulations is considered to be a higher obstacle than their unpredictability in 65 of the 72 countries, and more problematic than policy instability and crime in at least 57 of the 72 countries. Moreover, there is a high positive correlation between the

[5] A good review of all cases can be found in Klitgaard (1988)

importance attached to corruption and that attached to tax and other regulations. This motivates the inclusion of government regulations as an important part of the story.

The survey also points to the fact that, in the process of dealing with a corrupt government official, the investor has the option of having his case reexamined by a different agent. Specifically, 60% of the sample indicated that once they faced a corrupt official, they were able to "go to another official or to his superior" in order to obtain proper treatment at least "sometimes" (question 18). This suggests that the actual process of dealing with public officials can be modeled as a search process.

Finally, anecdotal evidence indicates that corrupt officials are only seldom penalized. We interpret this as evidence that bribing corrupt officials, instead of denouncing them, is in the best private interest of both parties (corrupt officials and private individuals). We therefore model the determination of the bribe level as a bargaining process.

While most of the theoretical literature has taken a microeconomic approach (see for example Shleifer and Vishny (1994), Cadot (1987)), we present in Section 2 a dynamic general equilibrium model of the impact of corruption on growth. In this model, bribery allows investors to avoid regulations imposed by the government. Given that these regulations decrease the returns to investment, the model predicts that corruption is not necessarily detrimental to economic growth. Specifically, corruption is shown to have two separate effects: on one hand, it fosters economic growth by allowing the private agents to circumvent existing regulations; on the other hand, corruption represents a drain on investment. The relative size of these effects determines the total impact of corruption on income growth.

The results obtained in our theoretical model are then corroborated by the empirical work presented in Section 3. Unlike previous studies, we allow for a non-monotonic relationship between corruption and growth by adding a quadratic term to the econometric specification. Moreover, we believe we cannot say anything about the behavior of economic agents in non-free countries like North Korea, where individuals face important restrictions on their choices and their liberties. Thus, we separate our sample of countries into two groups: those countries that are classified as free according to the Freedom House International Index, and those that are not. Then, by isolating those countries considered to be free, the growth maximizing level of corruption is found to be significantly greater than zero.

The specification that yields this outcome is found to be robust to the inclusion of several other variables and is preferred to a simple linear specification after comparing the goodness of fit and the robustness of the models. Furthermore, the paper addresses the issue of endogeneity differently than has been done before by conducting a regression in first differences and a Granger causality test. The empirical evidence also shows that the distinction made between free and not free countries is indeed important. Without freedom, the effects that corruption imposes upon economic growth may not work in the same fashion described by the arguments presented before. Finally, the conclusions and possible directions for future research are presented in Section 4.

2. Theory

2.1 Micro-foundations

The economy is populated by a large number of consumers who live forever; some of them also act as government officials. Officials have the responsibility to enforce a set of public regulations on investment that have a cost of α per unit of (gross) investment. Examples of such regulations are safety standards, zoning regulations, and licenses.

Officials are of two types. A proportion p of them is corrupt, and allows investors to ignore the regulations in exchange of a bribe b, which is a fraction of the value of the investment project. The remaining officials are honest, and they exercise no choice other than enforcing the regulations.

Whenever an agent decides to invest i units of capital, he has to be granted permission by government officials. Thus, besides making inter-temporal decisions on consumption and capital accumulation, agents must decide every period whether to pay bribes or abide by the regulations.

In addition, we will assume that all investment projects are identical so that their size can be normalized to one. Investors maximize their profits, but since investment projects are homogeneous and face the same risk-less rate of return, their problem amounts to maximizing their investment net of searching costs and bribes/regulation costs.

The investors first draw a ticket from a lottery and get an official who asks for a share α (when honest) or b (when corrupt) of the initial investment project, in order to grant the permission. Then, investors can either accept the official's offer or draw another ticket, in which case their payoff is discounted by a factor $\delta \in (0,1)$, which captures searching costs.

If an investor gets a corrupt official, his value function (per unit of investment) is,

$$V_C = \text{Max}\ \{1\text{-}b,\ \delta(p\ V_C + (1\text{-}p)\ V_H)\}. \qquad (1.a)$$

If he gets an honest official, his value function is,

$$V_H = \text{Max}\ \{1\text{-}\alpha,\ \delta(p\ V_C + (1\text{-}p)V_H)\}. \qquad (1.b)$$

Once the investor is faced with a corrupt official, a Nash bargaining process determines the resulting bribe charged. Formally, the equilibrium bribe function b*(p) is defined as:

$$b^* = \underset{\{b\}}{\arg\max}\ (b - \mu_C)(1 - b - \mu_I) \qquad (2)$$

where μ_C and μ_I are the corresponding payoffs for the corrupt official and the investor in the non-cooperative case. For this particular model, the payoffs in the case of no cooperation are $\mu_C = 0$ and $\mu_I = \delta(p\ V_C + (1\text{-}p)V_H)$.

An equilibrium for this model consists of a bribe function b*(p) that is defined by (2), and decision rules for investors that are consistent with the Bellman equations (1.a) and (1.b).

Solving for the investors decision rules conditional on the bribe level, and given that the solution to problem (2) is single valued, we find a unique equilibrium which can be of two types depending on the parameter values. The first type corresponds to the case where the investor always pays a bribe when faced with a corrupt official and always abides by the regulations when faced with an honest official. Solving for both Bellman equations we find that these equilibrium arises whenever the bribe b*(p) lies in the interval:

$$b^* \in [b^{min}(p,\alpha), b^{max}(p,\alpha)]$$

where b^{max} is the bribe level such that for any bribe greater than b^{max} it is always optimal for the investor to search for an honest official, and b^{min} is the level of bribe such that for any bribe below b^{min} it is always optimal for the investor to search for a corrupt official. This interval is obtained by substituting $V_C = 1 - b$ and $V_H = 1-\alpha$ into the equations (1.a) and (1.b), and obtaining the following inequalities:

$$1-b > \delta(p\,(1-b) + (1-p)(1-\alpha)) \quad \text{(A)}$$

$$1-\alpha > \delta(p(1-b) + (1-p)\,(1-\alpha)) \quad \text{(B)}$$

Simplifying both inequalities one obtains $b < 1-\dfrac{\delta(1-p)(1-\alpha)}{1-\delta p} \equiv b_{max}$ and $b > 1-\dfrac{(1-\alpha)-\delta(1-\alpha)(1-p)}{p\delta} \equiv b_{min}$, respectively. Furthermore, as shown in the appendix, the value b_{max} is greater than b_{min} for all values of p.

The second type of equilibrium corresponds to the case for which investors will always prefer to keep searching if faced with an honest official, and will always choose to pay the bribe when faced with corrupt officials. Again, by solving the Bellman equations we find that this equilibrium can only arise for $b < b^{min}$ and for a level of corruption p lying in an interval $[p^{min}(\alpha), 1]$[6], which ensures that $b^{min}>0$ at the interior of the interval. Therefore, a bribe compatible with this equilibrium must then lie in the interval

$$b \in [0, b^{min}(p,\alpha)]$$

Again, in order to obtain this interval, we substitute $V_C = 1 - b$ and

$V_H = \dfrac{\delta p(1-b)}{1-\delta(1-p)}$ (since in this equilibrium $V_H = \delta(pV_C + (1-p)V_H)$) into equations (1.a) and (1.b), and obtaining the following inequalities:

$$1-b > \delta\{p(1-b) + (1-p)\frac{\delta p(1-b)}{1-\delta(1-p)}\} \quad (3.a)$$

$$1-\alpha < \delta\{p(1-b) + (1-p)\frac{\delta p(1-b)}{1-\delta(1-p)}\} \quad (3.b)$$

Grouping all factors into the left hand side of inequality (3.a) and factoring out (1-b), one obtains the condition $b<1$; which is not binding at any time. From inequality (3.b) one obtains $b<1-\dfrac{(1-\alpha)(1-\delta+\delta p)}{\delta p}$, which after adding and subtracting the term

$(1+(1-\alpha)/\delta p)$ becomes $b<1-\dfrac{1-\alpha}{p\delta}+\dfrac{(1-\alpha)(\delta-\delta p)}{p\delta} = b_{min}$.

Finally, if $b^* > b^{max}$, investors will find it always optimal to keep searching until they get an honest official. In this case, a corrupt official would be better off by setting $b^* = b^{max}$, so $b > b^{max}$ would not arise as an equilibrium bribe level. In what follows, we choose to concentrate on the first type of equilibrium in which investment is conducted through both kinds of officials.

[6] See Appendix 1.

In order to solve for the equilibrium level of bribes, we need to determine the non-cooperative payoffs μ_C and μ_I. In the case of no cooperation, the corrupt agent obtains a payoff of zero and the investor is forced to search for another official. Therefore, $\mu_C = 0$ and $\mu_I = \delta(pV_C + (1-p)V_H)$. Using the symmetric nature of the problem, we obtain

$$V_C = \frac{\delta(1-p)(1-\alpha)}{1-\delta p} = 1-b^{max} \qquad \text{and} \qquad V_H = 1-\alpha.$$

Then, the Nash Bargaining problem can be specified as

$$\max_{\{b\}} \; (b \cdot (b^{\max} - b)) \tag{4}$$

The solution to (4) is given by $b^*(p) = b^{max}/2$. Once this equilibrium level of the bribe is determined, and given that the conditions for an interior solution are met[7], we can study the set of prices faced by the consumer in his inter-temporal allocation problem. To do this, we begin by defining the expected fraction of spending on investment that will accrue to the productive capital stock of the investor as θ:

$$\theta = p\,(1-b^*) + (1-p)(1-\alpha).$$

Since it is not the purpose of this paper to deal with uncertainty issues, we assume that each household diversifies its portfolio into many projects and interviews as many officials as projects he has. This is done so that, in the spirit of the law of large numbers, θ can be seen as the actual rate at which an agent can transform investment spending into new capital goods at every period of time.

To characterize θ note that its first two derivatives with respect to p are:

$$\frac{\partial \theta}{\partial p} = \alpha - b - p \cdot \frac{\partial b}{\partial p} \qquad\qquad \frac{\partial^2 \theta}{\partial p^2} = -2\frac{\partial b}{\partial p} - p\frac{\partial^2 b}{\partial p^2} < 0.$$

Although the first derivative of θ with respect to p cannot be signed, it can be shown to depend specifically on the size of α. As demonstrated in the appendix, θ reaches a unique maximum at a level p* of corruption, when the following sufficient conditions are met

$$p^* = 0 \qquad \text{if } \alpha < \frac{1-\delta}{2-\delta}$$

$$0 < p^* < 1 \qquad \text{if } \alpha > \frac{1-\delta}{2-\delta} \text{ and } \alpha < \frac{1}{2}$$

$$p^* = 1 \qquad \text{if } \alpha > \frac{1}{2}$$

Thus, the effect of corruption upon the variable θ depends on the size of α; and one cannot rule out any theoretical possibility. For reasonable parameter values, however, the first two possibilities seem more realistic[8]. Figures 1 and 2 illustrate the solution for the values α= 0.15, δ = 0.97 and show how the level of corruption that maximizes θ lies between zero and one.

The following section embeds the results obtained here into a growth model and analyses the impact of corruption on the rate of growth. In order to do this we begin by using θ to derive the constraints faced by the representative household in his inter-temporal allocation problem.

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[7] A sufficient condition is $\delta \le 2-\sqrt{2}+\frac{\left(1-\alpha\sqrt{2}\right)\left(\sqrt{2}-1\right)}{1-\alpha}$.

[8] Empirical evidence on the costs of government regulations indicates that the value of α ranges between 7% and 19% of GDP for OECD countries (see Guasch and Hahn (1999)). No empirical estimates of δ were available.

2.2 A Growth Model with Corruption

We now proceed to study the effects of corruption on the growth rate of output. To do so, we first build on the results of the last section to derive a household budget constraint, and state the general form of the household problem. Then, we derive the growth rate of output and examine its properties using a simple Ak production function.

Let i^P be productive investment, if d is the depreciation rate, we have:

$$k_{t+1}=(1-d)k_t+ i^P_t \quad . \tag{5}$$

Let i be spending in investment projects from a household point of view, then:

$$i^P_t = \theta \times i_t \quad , \tag{6}$$

$$i_t = i^P_t + r_t + b_t \quad . \tag{7}$$

Where r_t denotes the cost of regulations and b_t represents the bribes at time t.

The national account identity says:

$$y_t = c_t + i^P_t + r_t \quad . \tag{8}$$

As resources can be used for consumption, additions to the capital stock or can be lost in the form of regulation costs. Furthermore, if bribes are returned as lump-sum transfers, we have:

$$t_t + y_t = c_t + i^P_t + r_t + b_t \quad . \tag{9}$$

Where t_t represent the transfers at time t.

Note that the lump sum return of bribes can be seen as an accounting device: bribes imply a redistribution of wealth from investors to officials who, given that they cannot profitably deviate from b=b*, see them as lump-sum transfers. The way the distribution of bribes is modeled then has no effects on the growth rates, and for the purpose of this paper we could just assume they are destroyed.

The same applies for the cost of regulations r. The way we think about these resources is as goods that may enter into the utility function but do not add to the productive capital stock. In line with this idea, we chose to model r as pure losses to society, which can be motivated as agents having no (collective) choice on the level of regulations.

Using equations (6) and (7), equation (9) is equivalent to:

$$t_t + y_t = c_t + i^P{}_t/\theta \quad . \tag{10}$$

The above budget constraint shows that the growth effects of corruption are, in this model, similar in nature to those of a tax on investment.

The general form of the growth model can then be summarized by the following household problem:

$$\text{Max } \sum \beta^t u(c_t)$$

$$\text{s.t.} \quad \text{i) } t_t + y_t = c_t + i^P{}_t/\theta$$

$$\text{ii) } k_{t+1} = (1\text{-}d)k_t + i^P{}_t$$

In defining a candidate growth model, we choose to pick the simplest form for the technology that allows for policy to have growth implications. It can be seen however that the same results obtain where a model of the type of Rebelo (1991) or Jones and Manuelli (1990) is used instead.

Using iso-elastic utility and Ak technology (y= Ak), the common growth rate for all real variables is:

$$g = \beta\,(\,1 - d + \theta A\,)^{\sigma}$$

Thus, the growth rate inherits all the relevant features of θ. In particular, the level of corruption that maximizes the rate of growth can take any value between zero and one depending on the size of the government regulations.

3. Evidence

The main contribution of the empirical analysis presented here is to show that, in order to derive robust results, additional structure has to be imposed on the data by differentiation among "free" countries and "not-free" countries. Once this is done, we are able to derive the following set of results:

i) The growth rate is a hump-shaped function of the corruption level.

ii) A quadratic specification is preferred, in terms of goodness of fit, to the traditional linear specification.

iii) The growth maximizing level of corruption increases with the level of government expenditures under some specifications.

iv) For not-free countries, there is no statistical correlation between the level of corruption and the growth rate.

3.1 Description of the Data

The index of corruption used comes from Political Risk Services Inc., a private firm that annually publishes the International Country Risk Guide (ICRG). The ICRG contains a corruption index that covers the period 1982-1995; this index is an assessment of the degree of corruption prevailing in a certain country and is based on a survey made of foreign investors.

The ICRG as presented here ranges from 1 (most corrupt) to 10 (least corrupt). A lower number indicates that "high government officials are likely to demand special payments" and "illegal payments are generally expected throughout lower levels of government" in the forms of "bribes connected with import and export licenses, exchange controls, tax assessment, police protection, or loans" (Tanzi (1997)). In contrast with other indices, the ICRG looks directly into the frequency of corrupt acts among government officials.

We use the index of freedom from Freedom House International. Since 1970 they have conducted surveys that rank the rights and freedoms of individuals in several countries; these surveys are intended to fill out a checklist of elements that are considered essential for freedom.

This index is divided into political rights and the civil liberties. Each sub-index ranges from 1 to 7, where a lower number indicates a higher degree of freedom. To give and idea of what those numbers represent, their report[9] states that " as one moves down the scale below the category of 2, the level of oppression increases, especially in the areas of censorship, political terror and prevention of free association"[10].

Freedom House classifies countries as "free" if the sub-indices do not add more than five, as "partly free" (a gray area in their classification) if they add up between five and ten, and as "not free" if they add up to 11 or more. For the purposes of this study, countries will be categorized as free if the total index is less than six; however, the results remain unaltered if a value of 4, 5, 6, 7 or even 8 is chosen to separate the categories.

[9] Freedom in the World: 1996-1997

[10] After reading their report, it is clear that "moving down the scale below the category of 2" is intended to represent a movement in the index from 2 to 3 and higher.

The political rights sub-index was used to create a variable intended to approximate the degree of political instability within a country; this variable was constructed by taking the standard deviation of the political rights index for the period in question. Although this might not be a perfect measure of political instability, one would certainly expect that the countries that have a more volatile score in political rights are the ones who are less stable.

Other studies have used the probability of the opposition taking over, or the number of changes in power over a certain period in time, as a measure of political instability. However, these measures are evidently flawed, since a perfectly stable democracy is also likely to have frequent changes in power. Thus, the alternative proposed here is considered an improvement over other measures used before.

The average growth of GDP per-capita for the period 1984-1992 was obtained from the World Bank National Account Statistics as reported by Bruno and Easterly (1996). Although the same analysis can be conducted using the Barro-Lee data set without any change in the results; the World Bank statistics allowed us to work with a bigger sample.

Values of population growth, income per capita, and the total shares of investment and government expenditures in GDP were obtained from Summers and Heston (1991). All other variables like the secondary and primary school enrollment ratios where taken from the United Nations Educational, Scientific and Cultural Organization (UNESCO).

3.2 Empirical Analysis

The majority of the empirical work on growth accounting and corruption conducted in the past has followed the work of Mankiw (1992) and Barro (1994,1992). In these studies the rate of economic growth depends on the level of corruption and several other variables that include human and physical capital, initial level of income, etc. This type of framework (to which we will refer as "traditional" from now on) can be summarized in the following equation:

$$Growth = \alpha + \beta\, Corruption + \gamma\ (other\ variables) + \varepsilon$$

It is immediately apparent, however, that this traditional setting does not allow for the growth-maximizing level of corruption to differ from zero or infinity; and therefore, that it does not provide an ideal test for the broad body of theory introduced in the preceding sections. Thus, in order to overcome this limitation, an alternative specification is considered:

$$Growth = \alpha + \beta_1\ Corruption + \beta_2\ (Corruption)^2 + \gamma\ (other\ variables) + \varepsilon$$

By studying both formulations, the analysis will reveal that the distinction made between free and not-free countries is in fact pertinent. Furthermore, the non-traditional specification will show very robust results that confirm the existence of a positive growth maximizing level of corruption in those countries labeled as free.

Table 1 presents the results obtained for the traditional model. Each column shows the result of a different regression and the only difference between regressions is the number of explanatory variables. Under the simplest specification (column 1) the coefficient on corruption is found to be significantly different from zero (with a value of

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0.0034), however, as other relevant variables are included, the significance of this coefficient disappears.

The results reported here coincide with the ones obtained in other empirical studies. Mauro (1995) for example, using very similar models to the ones in columns (1) and (2), finds significant coefficients[11] for corruption of 0.002 and 0.003 respectively[12]. In his study, after controlling for other important determinants of growth, the coefficient on corruption becomes insignificant. In their study of growth and convergence, Keefer and Knack (1997) also reported that the coefficient on corruption becomes insignificant after other variables were included in their regressions.

Table 2 also uses the traditional model but separates the sample between free and not-free countries. For the free countries, the results are similar to those obtained for the entire sample, except now, the coefficients on corruption remain significant for column (2) also and the goodness of fit is improved in almost all regressions. For the not-free countries, in contrast, the results obtained differ completely form the ones shown in Table 1 and, even in the simplest regression, there seems to be no effect of corruption on growth.

The alternative specification is presented in Tables 3 and 4. When the complete sample is used (Table 3), the coefficients on corruption and corruption squared are never significantly different than zero. Thus, comparing the performance of the two models over the whole sample (outcomes of tables 1 and 3), it is not surprising that the traditional specification had been preferred in the past.

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[11] Mauro's sample is 58 countries. The sample used here is as large as 94 and as small as 67 depending on the data available for different regressions.

However, once the two sub-samples are considered separately (Table 4), the situation is reversed. For the case of free countries, the alternative specification yields a much bigger explanatory power (78%) than the traditional one (31%) and obtains coefficient estimates that are robust to the inclusion of many other independent variables.

These coefficients are significant at the 1% level for all regressions and their sign, as expected, suggests the existence of a positive growth maximizing level of corruption. Specifically, corruption was found to become detrimental to economic growth for ICRG values lower than 7.7, 7.12 and 7.12 in columns (1), (2) and (3) respectively[13] (it is important to remember that a lower ICRG number denotes a higher incidence of corruption).

As shown in the appendix countries like Botswana, Malaysia, Singapore, Spain and Costa Rica (which have rates of growth well above the average) have indexes of corruption that are remarkably close to the estimated optimal level of corruption.

The coefficient of the interaction term between corruption and the share of Government expenditure is particularly interesting, since its negative sign implies that the growth-maximizing level of corruption is bigger for those countries in which the government takes a bigger share of the economic activity. Such phenomena could be explained if corruption was harder to control in bigger governments (as suggested in Klitgaard's model) or if the bigger and more complicated bureaucracies gave way to corruption (as Friedrich (1972), McMullan (1961) and others had pointed out).

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[12] Although not reported in the table, the results are almost identical when 2SLS procedures are used instead of OLS. Following Mauro's work, the index of ethnolinguistic fractionalization was used as an instrument

[13] In order to calculate those, the average size of the government was used.

For the not-free countries, as was the case with the traditional framework, the alternative formulation does not find a significant link between the incidence of corruption and the rate of growth. Thus, the distinction made of free and not free appears to be relevant for the study of corruption and its consequences.

3.3 The Endogeneity of Corruption

The results presented in Table 4 are susceptible to two major criticisms. First, it is possible that corruption and growth respond simultaneously to an omitted factor. Such factor could be a cultural disposition towards leisure or morality, the legal framework, the historical evolution of the nation in question, the date of independence, etc. Second, one may think that the incidence of corruption is directly affected by the rate of economic growth; as for example, it could be the case that rich, fast-growing countries have more resources to combat and control corruption.

In either case, corruption would be correlated with the error term in the OLS regression and the estimates would be biased. Thus, in order to overcome this difficulty, several authors in the past included an instrumental variable and conducted a two stage least squares regression. In theory, this is a perfectly valid procedure, in practice; however, it is very difficult to find a valid instrument.

Even logical candidates such as the Index of Ethnolinguistic Fractionalization (ELF)[14] used by Mauro (1995) and others were inadequate for this study. In the specific case of the ELF, although it is correlated with corruption in the whole sample, when considering free countries only, this correlation disappears.

Thus, in order to address the first criticism, the sample was separated in two periods (1984-1988 and 1989-1992), and an OLS regression was conducted using the first differences of each variable. This procedure is equivalent to allowing for fixed effects and would diminish considerably the effects of potentially omitted variables like the ones described above.

Table 5 presents the results obtained in this regression. As shown, the main result remains unchanged, as the coefficients of both corruption and corruption squared preserved the expected sign and stay significant at the 1% level. As for the second criticism, let us assume that economic growth today determines the present and future level of corruption but that the rate of growth today has no direct effect upon the level of corruption in the past. Thus, consider the following equation, where the subscript t stands for time:

$$Growth_{t} = \alpha + \beta\, Corruption_{t-1} + \beta_2 (Corruption_{t-1})^2 + \gamma\, (Other\ Variables_{t}) + \varepsilon$$

This specification does not suffer from the shortcomings exposed above; however, the coefficient β could still be picking up the correlation between growth at time t and growth at time t-1 (if those were correlated). Therefore, in order to complete the estimation, the equation must be modified as follows:

$$Growth_{t} = \alpha + \beta\, Corruption_{t-1} + \beta_2 (Corruption_{t-1})^2 + \gamma\, (Other\ Variables_{t}) + \phi (Growth_{t-1}) + \varepsilon$$

[14] Although not free of criticisms, the ELF is the most used instrument in a very short list.

Table 6 reports the estimations obtained using these specifications. As before, the estimated coefficients remained significant at the 1% level.

Finally, in Table 7 we modify the first differences specification used in Table 5 so, instead of dividing the sample into two different groups, the complete sample was used and the coefficient of corruption was allowed to differ from free to not free countries by using dummy variable interactions. As can be seen in the table, our results remain unchanged.

Summarizing the analysis, the empirical evidence suggests the existence of a quadratic relationship between corruption and income growth for the case of free countries. This is to say, that controlling for all other characteristics, the level of corruption that maximizes the rate of growth is greater than zero.

This result can be interpreted in the light of the model of Section II. When the level of corruption is low, paying bribes is cheaper than abiding by the regulations, so that increasing the level of corruption will only make it more likely that an investor gets the chance of bypassing the regulations and therefore face a higher investment/accumulation ratio θ.

As the proportion of corrupt officials increase, the level of bribes rises over the cost of abiding by the regulations, and further increments in the corruption level only increase the likelihood that an investor will have to pay a high "corruption tax", therefore decreasing the net return to his investment and at the same time the growth rate of the economy.

4. Conclusions and Future Research

In this paper we demonstrate how, in the presence of government regulations, the growth maximizing level of corruption is not necessarily equal to zero. In addition, we present new empirical evidence that suggests the existence of a hump-shaped relationship between corruption and the economic growth of free countries. This finding remains unchanged under several specifications even after conducting a first difference regression and controlling for endogeneity.

The empirical literature that noticed a linear relationship between corruption and growth failed to differentiate between free and not free countries. Once this differentiation is made the alternative specification proposed in this study is preferred to the traditional one in terms of robustness and goodness of fit. Thus, the incorporation of the Freedom Index proves to be a key element in the analysis and may be an important avenue of future research.

The main result obtained here: that the growth maximizing level of corruption is not necessarily equal to zero, confirms the predictions of the theory of political economics developed in the last three decades. The specific model borrows from the game theoretic approach to corruption, pioneered among others by Cadot, and goes a step further by showing how the results can be embedded into a modern endogenous growth model. In doing so, we offer a general equilibrium explanation for the relationship between corruption and growth.

In constructing the model, a number of issues have deliberately been left aside. In particular, important topics like the effects of corruption upon social welfare, income distribution, investment uncertainty, and allocation of public expenditures were not discussed here. Similarly, the lack of relevant data did not allow us to identify the specific reasons why corruption has a different impact at different levels. We leave these issues for further research.

Table 1
Dependent Variable: Per Capita GDP Growth (1984-1992 average)

Independent Variables	(1)	(2)	(3)	(4)
Corruption	**0.0034** **(3.908)**	**0.0022** **(1.75)**	**0.0005** **(0.344)**	**0.0001** **(1.09)**
I/GDP			0.00134 (3.249)	0.001 (2.29)
G/GDP			0.00017 (0.571)	0.0003 (1.07)
Political Instability			-0.0017 (-0.245)	-0.002 (-0.33)
Primary education			0.0064 (0.452)	0.006 (0.41)
Secondary education		0.0008 (0.069)	-0.0267 (-1.63)	-0.32 (-1.95)
Gdppc84			0.0000 (0.739	0.0000 (0.78)
POP		-0.2337 (-0.944)	-0.1485 (-0.618)	-0.12 (-0.53)
Lat.Amer				-0.004 (-0.7)
Africa				-0.015 (-1.93)
Constant	0.98 (183.22)	0.99 (104.8)	0.98 (61.3)	.99 (59)
Number of Observations	94	77	74	74
R^2	.14	.115	.261	.3

All results obtained with OLS regressions. T-statistics are in parentheses.

Table 2
Dependent Variable: Per Capita GDP Growth (1984-1992 average)

Independent Variables	Free Countries (1)	(2)	(3)	Not-Free Countries (1)	(2)	(3)
Corruption	**0.00207** **(2.308)**	**0.0038** **(2.334)**	**0.0007** **(0.44)**	**0.0030** **(1.787)**	**-0.0003** **(-0.18)**	**-0.0004** **(-0.16)**
I/GDP			0.0007 (1.34)			0.0013 (1.94)
G/GDP			0.001 (2.19)			-0.0005 (-0.10)
Political Instability			0.0018 (0.22)			0.0026 (0.22)
Primary Education			0.083 (1.97)			0.0015 (0.07)
Secondary Education		-0.014 (-0.90)	-0.021 (-1.39)		-0.017 (-0.87)	-0.029 (-1.15)
Gdppc84		-.0000 (-0.45)	0.0000 (0.84)		0.000 (2.34)	.00000 (0.362)
POP		-0.138 (-0.51)	-0.57 (-2.14)		-0.307 (-0.90)	0.038 (0.107)
Lat.Amer			0.0054 (0.72)			-0.005 (-0.52)
Africa			0.018 (1.59)			-0.0071 (-0.62)
Constant	1.00 (148.6)	1.003 (78.2)	.93 (25.9)	.98 (116.4)	1 (76.1)	.99 (39.4)
Number of Observations	37	31	30	57	46	44
R^2	.13	.24	.60	0.054	.15	.23

All results obtained with OLS regressions. T-statistics are in parentheses.
Countries catalogued as free if the total index of freedom was no more than 6

Table 3
Dependent Variable: Per Capita GDP Growth (1984-1992 average)

Independent Variables	(1)	(2)	(3)	(4)
Corruption	**0.0042** **(1.12)**	**0.0025** **(0.557)**	**0.002** **(0.35)**	**0.003** **(0.59)**
Corruption squared	**-0.00007** **(-0.22)**	**-0.00014** **(-0.339)**	**-0.00008** **(-0.209)**	**-0.00016** **(-0.37)**
Corrup * G			**-0.00003** **(-0.203)**	**-0.00002** **(-0.189)**
I/GDP			0.0013 (3.20)	0.0011 (2.58)
G/GDP			0.00032 (0.427)	0.0004 (0.61)
Political Instability			-0.0018 (-0.25)	-0.0035 (-0.47)
Primary Education		0.0168 (1.17)	0.0065 (0.443)	0.0065 (0.43)
Secondary Education		-0.021 (-1.282)	-0.026 (-1.58)	-0.03 (-1.8)
Gdppc84		0.0000 (1.76)	0.0000 (0.673)	0.0000 (0.314)
POP		-0.232 (-0.941)	-0.137 (-0.535)	-0.147 (-0.575)
Lat.Amer.				0.0024 (0.363)
Africa				-0.011 (-1.47)
Constant	0.984 (93.6)	0.99 (60.6)	0.98 (36)	0.98 (35.3)
Number of Observations	94	77	74	74
R^2	.142	.166	.26	.289

All results obtained with OLS regression. T-statistics are in parentheses.

Table 4
Dependent Variable: Per Capita GDP Growth (1984-1992 average)

	Free Countries			Not-Free Countries		
Independent Variable	(1)	(2)	(3)	(1)	(2)	(3)
Corruption	**0.0185** **(3.22)**	**0.022** **(3.92)**	**0.0219** **(4.1)**	-0.0012 (-0.20)	0.009 (0.84)	0.009 (0.76)
Corruption squared	**-0.0012** **(-2.89)**	**-0.0010** **(-3.07)**	**-0.0010** **(-3.04)**	0.0004 (0.733)	-0.0003 (-0.45)	-0.0003 (-0.43)
Corrup * G		**-0.0004** **(-2.68)**	**-0.0001** **(-3.25)**		-0.0003 (-1.2)	-0.0002 (-1.00)
I/GDP		0.0003 (0.831)	0.0005 (1.27)		0.0015 (2.34)	0.0014 (2.03)
G/GDP		0.004 (3.62)	0.0049 (4.08)		0.0011 (0.98)	0.001 (0.87)
Political Instability		-0.004 (-0.63)	-0.0025 (-0.39)		0.005 (0.49)	0.0037 (0.31)
Primary Education		0.119 (3.43)	0.129 (3.68)		0.0015 (0.08)	0.002 (0.13)
Secondary Education		-0.012 (-1.0)	-0.0034 (-0.27)		-0.03 (-1.2)	-0.031 (-1.19)
Gdppc84		0.000 (0.746)	0.000 (1.31)		0.000 (0.02)	-0.000 (-0.08)
POP		-0.26 (-1.25)	-0.422 (-2.05)		0.253 (0.62)	0.221 (0.51)
Lat.Amer.			0.011 (1.88)			-0.002 (-0.18)
Africa			0.013 (1.58)			-0.004 (-0.35)
Constant	0.95 (52.2)	0.78 (15.12)	0.75 (14.9)	0.99 (70.1)	0.95 (21.8)	0.95 (19.5)
Number of Observations	37	30	30	57	44	44
R^2	.30	.75	.8	.02	.25	.25

All results obtained with OLS. T-statistics are in parentheses.

Table 5
Dependent Variable: Change in Per Capita GDP Growth

Independent Variables	
ΔCorruption	**0.067** (**4.28**)
ΔCorruption squared	**-0.0033** (**-3.26**)
Δ(Corrup *G)	-0.0005 (-1.08)
Δ(I/GDP)	0.0006 (0.55)
Δ(G/GDP)	-0.0032 (-0.79)
ΔPolitical Instability	0.008 (1.00)
ΔPrimary Education	0.286 (1.54)
ΔSecondary Education	0.108 (1.08)
ΔGdppc	0.000 (0.757)
ΔPOP	-0.861 (-1.84)
Constant	-0.021 (-4.8)
Number of Observations	25
R^2	.76

T-statistics in parentheses.

Table 6
Dependent Variable: Per Capita GDP Growth (1989-1993 average)
All independent variables refer to the respective 1989-1993 values except for the values of corruption that correspond the 1984-1988 period.

Independent Variables	(1)	(2)
Corruption	**0.014** **(2.13)**	**0.022** **(2.47)**
Corruption squared	**-0.0011** **(-2.29)**	**-0.0015** **(-2.66)**
Corrup *G	-0.0001 (-0.78)	-0.0002 (-1.28)
I/GDP	0.00011 (0.018)	0.0003 (0.53)
G/GDP	0.0014 (1.18)	0.0025 (1.72)
Political Instability	-0.013 (-1.06)	-0.015 (-1.24)
Primary Education	-0.053 (-0.37)	-0.009 (-0.064)
Secondary Education	0.013 (0.74)	0.014 (0.764)
Gdppc1989	-0.000 (-0.053)	-0.000 (-0.17)
POP	-0.16 (-0.48)	-0.21 (-0.64)
Growth 84-88		-0.399 (-1.26)
Constant	1.01 (7.11)	1.33 (4.6)
Number of Observations	26	26
R^2	.35	.42

T-statistics in Parentheses

Table 7
Dependent Variable: Change in Per Capita GDP Growth

Independent Variables	
ΔCorruption	**0.03616** **(2.72)**
ΔCorruption squared	**-0.0029** **(-3.15)**
Δ(Corrup *G)	-0.00011 (-0.32)
ΔCorruption* Dummy	-0.087 (-3.00)
ΔCorpn. sqrd. * Dummy	0.0055 (2.28)
Δ(Corpn *G)* Dummy	0.001 (2.19)
Δ(I/GDP)	0.003 (2.86)
Δ(G/GDP)	-0.005 (-2.39)
ΔPolitical Instability	-0.008 (-1.7)
ΔPrimary Education	0.059 (1.167)
ΔSecondary Education	-0.124 (-1.93)
ΔGdppc	-0.000 (-1.83)
ΔPOP	-1.452 (-2.54)
Dummy	0.025 (2.933)
Constant	-0.0116 (-2.36)
Number of Observations	61
R^2	.57

T-statistics in parentheses

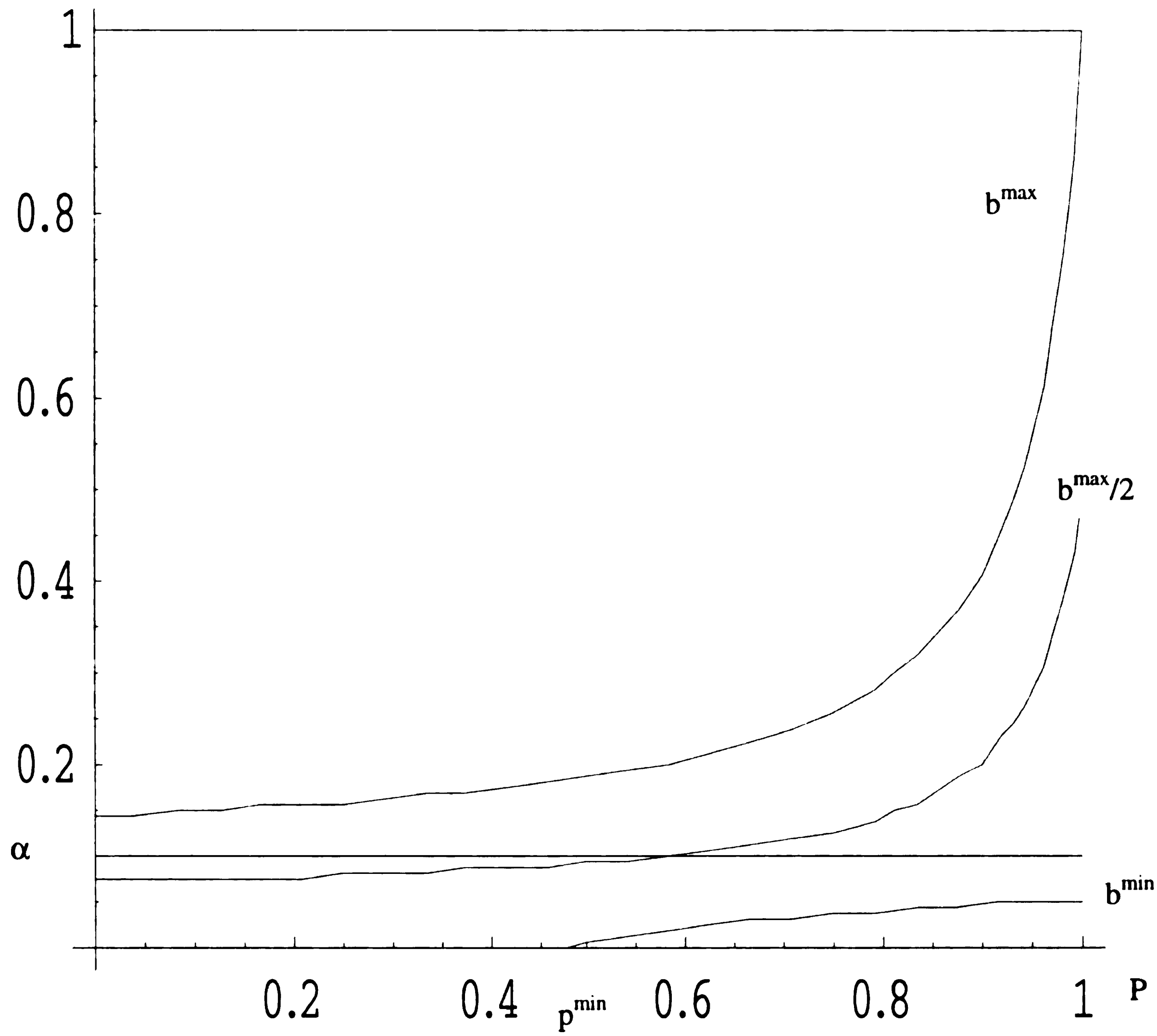

Figure 1. Bribe Functions (α=0.15, δ=0.97)

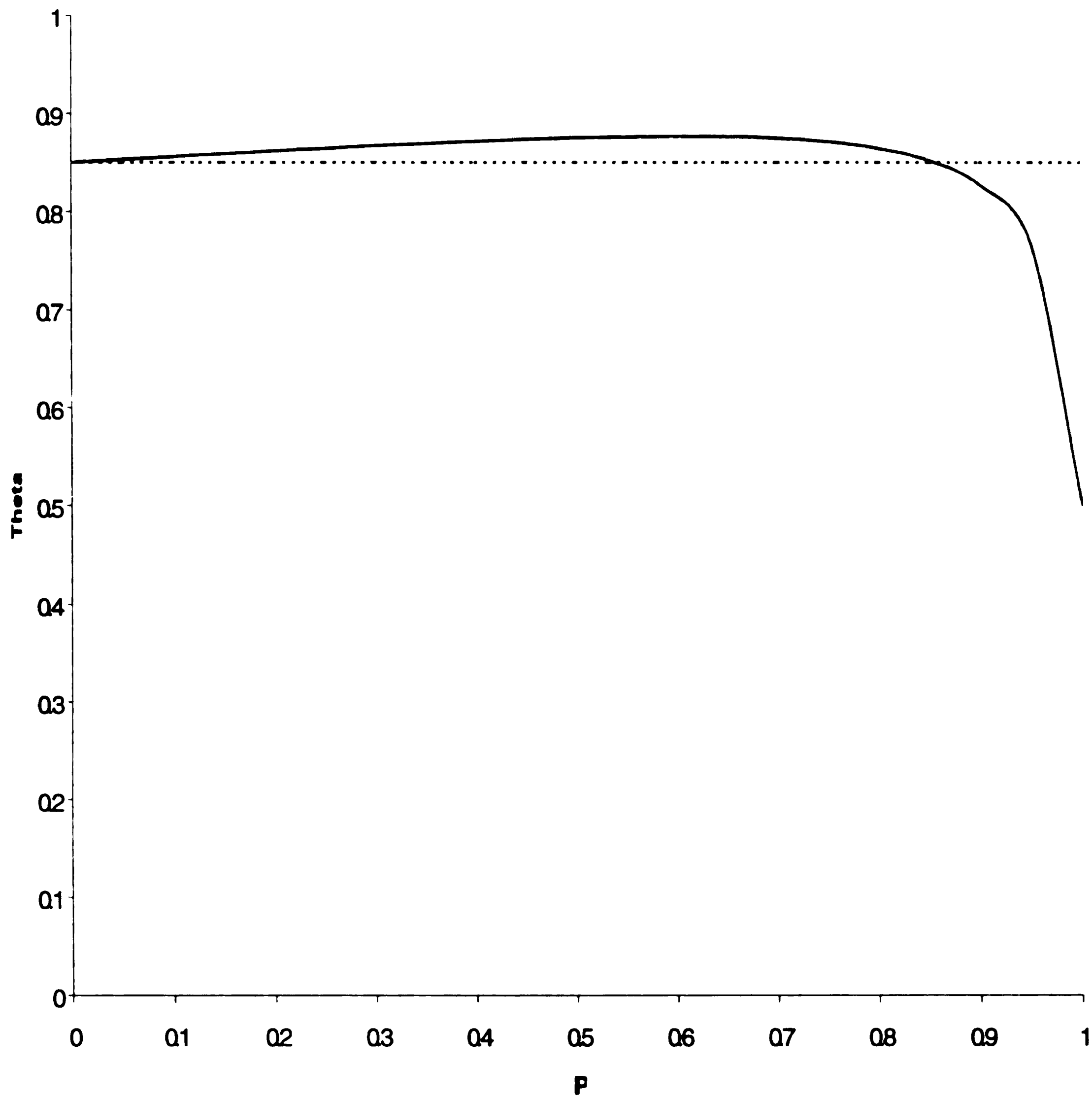

Figure 2. The Investment/accumulation Ratio

APPENDICES

Appendix 1: Mathematical Appendix

One needs to show that $b_{max} > b_{min}$ for all values of p. In order to do this, let's first write down the expression $b_{max} > b_{min}$:

$$1-\frac{1-\alpha}{p\delta}+\frac{(1-p)(1-\alpha)}{p}<1-\frac{\delta(1-p)(1-\alpha)}{1-\delta p}$$

Simplify this expression and obtain

$$(1-\alpha)\left[\frac{1}{p\delta}-\frac{(1-p)}{p}\right]>\frac{(1-p)(1-\alpha)\delta}{1-\delta p}\Rightarrow\frac{1}{p\delta}>\frac{\delta(1-p)}{\delta p}+\frac{\delta(1-p)}{1-\delta p}$$

Finally, add the terms in the right hand side and multiply both sides by $p\delta$ to obtain

$1>\frac{\delta(1-p)}{1-\delta p}$. Given that both p and δ are numbers between zero and one, it is clear after the above simplifications that the inequality $b_{min}<b_{max}$ will always hold. Q.E.D.

The Behavior of θ

Consider the following derivatives under the assumptions made before:

$$\frac{\partial\theta}{\partial p}=\alpha-b-p\cdot\frac{\partial b}{\partial p} \qquad \frac{\partial^2\theta}{\partial p^2}=-2\frac{\partial b}{\partial p}-p\frac{\partial^2 b}{\partial p^2}<0$$

$$\frac{\partial^2 b^*}{\partial p^2}=\frac{\delta(1-\delta)(1-\alpha)}{2(1-\delta p)^2} \qquad \frac{\partial^2 b^*}{\partial p^2}=\frac{\delta^2(1-\delta)(1-\alpha)}{(1-\delta p)^3}$$

Given that both, b* and $\frac{\partial b^*}{\partial p}$, are increasing functions of p, one can state sufficient conditions for the growth maximizing value of p to be zero, one or any value between zero and one. Particularly, if $\alpha < (b^* - p\frac{\partial b^*}{\partial p})|_{p=0}$ then θ is a decreasing function of p for all values of p and is maximized at p=0. If $\alpha > b^*|_{p=1} + \left.\frac{db^*}{db}\right|_{p=1}$ θ is an increasing function of p for all values of p and is maximized at p=1. Finally, if $\alpha > b^*|_{p=0}$ and $\alpha < b^*|_{p=1} + \left.\frac{db^*}{db}\right|_{p=1}$, θ initially increases with p but eventually decreases and attains its maximum at a value p between zero and one.

The Nash bargaining equilibrium bribe $b^* = \frac{b^{\max}}{2}$ can be used as an specific case. The values provided in the text follow.

Appendix 2: Variable Definitions

Corruption: Average ICRG index for the period 1984-92

Corruption squared: Corresponds to the square of corruption

I/GDP: Average total investment share of GDP

G/GDP: Average total government expenditures share of GDP

Political instability: Degree of political instability approximated by the standard deviation of the political rights index provided by Freedom House International

Primary education: primary school enrollment among total population

Gdppc84: Gross domestic product per-capita in 1984

Gdppc89: Gross domestic product per-capita in 1989

POP: Average population growth

*Corrup*G* : Interaction term between Corruption and the government expenditures share

Lat.Amer: Dummy variable taking the value of 1 for Latin American countries and 0 otherwise

Euro: Dummy variable taking the value of 1 for European countries and 0 otherwise

Africa: Dummy variable taking the value of 1 for African countries and 0 otherwise

Dummy: Dummy variable taking the value of 1 for countries with a freedom index of 10 or more, and 0 otherwise.

Appendix 3: Average Indexes of Corruption, Freedom and Growth (1984-1992)

Country	ICRG	Freedom	Growth
Zaire	0.00	6.38	0.96
Bangladesh	1.18	3.96	1.02
Haiti	1.60	5.83	0.97
Paraguay	1.74	4.17	1.00
Guyana	2.01	3.96	1.00
Indonesia	2.22	5.67	1.04
Sierra Leon.	2.65	5.58	0.99
Gabon	2.71	5.04	0.98
Mali	2.78	4.92	1.01
Bolivia	2.99	2.54	0.99
Pakistan	3.19	4.21	1.03
Nigeria	3.26	5.63	1.01
Sudan	3.26	6.21	0.97
Guatemala	3.33	3.92	1.00
Guinea B	3.33	5.54	1.01
Honduras	3.33	2.63	1.00
Togo	3.33	5.83	0.99
Philippines	3.40	3.04	0.99
Jamaica	3.61	2.25	1.01
El Salvador	3.75	3.29	1.01
Sad. Arabia	3.96	6.67	0.98
Zambia	4.17	4.33	0.97
Cameroon	4.17	5.96	0.96
Uganda	4.17	5.00	1.00
Egypt	4.24	4.92	1.01
Surinam	4.32	4.08	0.96
Ethiopia	4.32	6.17	0.97
Morocco	4.44	4.67	1.01
Trinidad	4.44	1.21	0.98
India	4.51	3.04	1.03
Ghana	4.58	5.58	1.02
Kenya	4.86	5.75	1.00
Romania	4.93	5.63	0.96
Peru	4.93	3.54	0.98
Tunisia	4.93	5.13	1.02
Venezuela	4.93	2.13	1.01
Colombia	5.00	3.00	1.02
Congo	5.00	5.33	0.98
Dom. Rep.	5.00	2.46	1.00
Ecuador	5.00	2.33	1.01
Gambia	5.00	3.25	1.00
Mexico	5.00	3.83	1.00
Senegal	5.00	3.75	0.99
Sri Lanka	5.00	4.08	1.03
Thailand	5.00	3.42	1.07
Uruguay	5.00	2.04	1.03
Chile	5.07	3.63	1.05
Turkey	5.21	3.63	1.03

Country	ICRG	Freedom	Growth
Iran, Is	5.35	5.79	0.98
Zimbabwe	5.49	4.96	1.00
Jordan	5.56	4.54	0.99
Cote d'Ivore	5.62	5.42	0.96
Bahrain	5.69	5.42	0.98
Malta	5.76	1.58	1.05
Guinea	5.83	5.88	1.00
Niger	5.83	5.46	0.97
Algeria	6.04	5.71	0.99
Malawi	6.04	5.75	0.99
Burkina F.	6.06	5.58	1.01
Argentina	6.18	2.00	1.00
Italy	6.25	1.21	1.02
Brazil	6.32	2.58	1.00
Botswana	**6.46**	**2.13**	**1.06**
Madagascar	6.67	4.29	0.98
Malaysia	**7.01**	**4.33**	**1.04**
Spain	**7.01**	**1.33**	**1.03**
Poland	7.36	3.46	1.00
Hungary	7.50	3.21	0.99
Greece	7.64	1.79	1.02
Portugal	**7.78**	**1.29**	**1.03**
Singapore	**7.92**	**4.50**	**1.05**
Austria	8.33	1.00	1.02
Costa Rica	**8.33**	**1.13**	**1.02**
Israel	8.33	2.00	1.02
Japan	8.33	1.29	1.04
United S	8.40	1.00	1.02
Belgium	8.61	1.00	1.02
South Africa	8.82	4.58	0.99
France	8.89	1.50	1.02
United K	8.96	1.25	1.02
Canada	10.00	1.00	1.02
Denmark	10.00	1.00	1.02
Finland	10.00	1.33	1.01
Iceland	10.00	1.00	1.01
Luxemburg	10.00	1.00	1.04
Netherlands	10.00	1.00	1.02
Norway	10.00	1.00	1.02
Sweden	10.00	1.00	1.01
Switzerland	10.00	1.00	1.01

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CHAPTER 2

REGULATIONS, CORRUPTION AND INCOME INEQUALITY

1. Introduction

Recently, there has been increased interest among economists in studying the macroeconomic implications of a country's political institutions. Specifically, it has been argued that different elements like the access to political power, the rule of law, corruption, economic freedom, bureaucratic efficiency, etc., have important influences on the behavior of societies and affect both the creation and the distribution of wealth (see for example Johnston (1989), Atkinson (1997), Keefer and Knack (1997), Guasch and Hahn (1999), Hillman and Swank (2000)). All over Latin America and in most of the developing world two of these elements stand above the rest: cumbersome government regulations and corruption.

On the one hand, the amount of government regulation and the excessive paper work associated with it have become obstructive for economic agents who wish to invest. De Soto (1989), for example, describes this clearly for the Peruvian economy, where to legally set up a (fictitious) clothing factory took 289 days and $1231 in related expenses (an amount equivalent to 32 minimum monthly wages at the time) including necessary bribes[15]. De Soto also reports similar problems for the housing and transportation industries, where the majority of construction sites and transport vehicles operate without official permits.

[15] "Even to get a license to open a street kiosk or sell from a pushcart…" takes "forty three days of commuting between bureaucrats and $590.56".

Similar evidence of obstructive government regulations is often encountered throughout the developing world. In 1997, for example, the World Bank conducted a survey in 72 countries and asked firm managers to rate the relative importance of different obstacles for the normal operation of their projects (see Brunnetti, Kisunko and Weder (1998)). The results of the survey exposed tax regulations, along with other types of government regulations and corruption, as the worst obstacles for doing businesses. The level of these regulations was considered by the businessmen to be a higher obstacle than their unpredictability in 65 of the 72 countries, and more problematic than policy instability and crime in at least 57 of the 72 countries[16].

On the other hand, in most of these economies it is understood that certain public officials can grant investors the right to ignore these regulations (or at least eliminate the costs associated with them) in exchange for a bribe or a "gift". Corruption is such a pervasive phenomenon that citizens "have accepted it as a social rule" (Marjit et al. (2000)) and the extent of corruption is determined by the costs associated with bureaucratic delays and regulations. Gray and Kaufmann (1998), for example, reported a "positive relationship between the extent of bribery and the amount of time that enterprise managers spend with public officials". Similarly, as shown in Figure 1, the data collected by the survey "Obstacles for Doing Business" (1997) can be used to illustrate a positive correlation between the level of corruption and the burden imposed by government regulations as perceived by the businessmen surveyed[17].

[16] Further evidence for specific countries can be found on the World Bank's World Development Report (1997).
[17] The variables used to create this average were: Regulations for starting a new business/new operation, Regulations of foreign trade and Tax regulations.

In the aggregate, the combination of bribery and excessive red tape not only represents a drain on investment but can also affect the distribution of income. Given the presence of cumbersome bureaucratic rules, corruption frequently takes the form of cash bribes to junior officials, who control the paperwork associated with such rules and, therefore, are able to reduce the legal, administrative and time costs for the investors. As observed by Lowder (1989), this sort of corruption often acts as a "service charge" or fee charged by the official in exchange for his services without regard of who is paying the bribe. Thus, the burden imposed by this practice is disproportionately severe for the poorest.

A similar conclusion was obtained by the European Bank for Reconstruction and Development in their Transition Report for 1999 (EBRD (1999)). Their study shows that the burden of bribes necessary for investment is higher for smaller investors; in fact, the EBRD figures show that on average, the bribes paid by small Eastern European firms as a percentage of annual revenues was twice that paid by large firms. Furthermore, the study attributes the increased level of corruption during the latest years to the increased willingness of businessman to pay bribes in order to keep "the state from wasting management time".

In addition, the distributional consequences of this type of corruption can also arise from the way in which bribe revenues are allocated among the population. On this matter, the anecdotal evidence suggests that richer individuals are likely to receive a much bigger share of corruption revenues than poorer ones. In almost every Latin American country, for example, high-ranking officials have been accused of "bending the rules" in order to favor sympathetic businesses and personal friends with bureaucratic promotions, government loans or privatization contracts (Serbin (1993), Manzetti and Blake (1996), Klitgaard (1988)).

In her study of Cuenca (Ecuador), Lowder (1989) concludes "there is little doubt that particular groups have benefited disproportionately from the central government's development policies and that the distribution of resources was orchestrated by an elite". Furthermore, she explains how Cuenca's select few owe their position to their "inherited status" and "blood ties", and not to a democratic selection. Similar descriptions have also been made for countries like China, Italy, Nigeria, Kenya, Russia, India, Uruguay, etc. (Rowley (2000), Levin (2000), Tanzi (1995), Klitgaard(1988)).

Thus, even when in principle there exists competition for votes to determine who controls the seat of political power, it is other factors like wealth, blood, family history, social status or education level that determine ultimately who is to benefit from these privileged positions and the rents generated by corruption (see for example Lowder (1989), Rowley (2000), Rauch and Evans (2000)). In the words of Vargas Llosa when referring to Latin America, "the names of the favored individuals or consortia change with each government, but the system is always the same: not only does it concentrate the nation's wealth in a small minority but it also concedes to that minority the right to that wealth" (De Soto (1989)).

Although central to the economic reality of several developing regions, the related literature on these topics remains sparse, especially with respect to the distributional aspects of institutionalized corruption and red tape. In a theoretical study, Norris (1998) showed that an economy in which access to political positions implies the acquisition of economic rents as well, it is the richer individuals who have a stronger incentive to join political life. Norris does not explore the macroeconomic implications of her conclusions, nor does she analyze the role of investment regulations. On the empirical side, Sarel (1998) reported a positive correlation between the Gini coefficient and the level of corruption using a cross-section of countries. The empirical work on distributional issues, however, is severely constrained by the lack of adequate data sets on income inequality, corruption, and the costs of regulations.

With respect to the effects of corruption and bureaucratic efficiency on the creation of wealth the literature is more generous. Authors like Mauro (1995), Keefer and Knack (1997) and Hall and Jones (1999), for example, have found empirical evidence showing that increases in measures of corruption, bureaucratic delay and institutional inefficiency across countries are negatively correlated with the average growth rate. Others like Méndez and Sepúlveda (2000) analyzed this matter from a theoretical perspective and concluded that high levels of corruption have a detrimental effect on growth even in the presence of costly government regulations.

This paper studies the effects of widespread corruption on both the aggregate level of income and the inequality of the income distribution. It presents a general equilibrium model in which individuals face a set of bureaucratic regulations, which they can comply with or they can circumvent by paying a bribe to a government official. The model assumes a heterogeneous population and acknowledges the existence of corruption revenues that can be distributed among the individuals in a variety of ways. In order to do this, a variant of the Diamond (1965) overlapping generations model is developed in which the rents of corruption are allocated according to an exogenous parameter that determines how unequal the distribution of these rents is. Then, by solving the model one is able to study the distributional consequences of corruption and its impact on the steady state level of income from a theoretical point of view.

The next section of the paper presents the basic theoretical model, the equations that characterize the steady state equilibrium and the comparative statics resulting from its numerical solution. Section 3 expands this basic model by endogenizing the bribes charged by the corrupt officials and conducts numerical exercises similar to those in Section 2. Finally, Section 4 provides some conclusions and possible areas of future research.

2. The Basic Model

The economy is populated by a large number of consumers who live two periods, youth and old age. Each individual i is endowed with l_i units of effective labor, where l_i is distributed exogenously along the interval $(0,\infty)$ according to the probability density function f (l). When young, the individual supplies his effective labor inelastically in exchange for the wage rate per unit of effective labor w. He then allocates his total income between consumption and investment and gives birth to exactly one other person. At old age, the individual receives income from savings, consumes it all and disappears from the economy.

The preferences of all individuals of generation t are represented by the same utility function $U(c_t, c_{t+1})$, where c_t is consumption at time t and c_{t+1} is consumption at time t+1. In this model, $U(c_t, c_{t+1})$ takes the form

$$U(c_t, c_{t+1}) = \ln c_t + \beta \ln c_{t+1}, \tag{1}$$

where β represents a time discount factor.

The economy's aggregate production function exhibits constant returns to scale and is expressed as

$$Y_t = A\, K_t^{\alpha}\, L_t^{1-\alpha} \qquad (2)$$

where Y_t is total output at time t, K_t is the aggregate stock of capital at time t and L_t is aggregate effective labor supplied at time t, which is defined as

$$L_t = \int_0^{\infty} l \cdot f(l) dl . \qquad (3)$$

Thus, in what follows, the density function f(l) is restricted so that the value L_t exists and is finite at all times. In addition, the productive sector is assumed to be competitive so that the marginal products of capital and labor determine both the price of capital and the wage rate, respectively.

The government in this economy is composed of a number of public officials whose single function is to impose a set of regulations on investment. For simplicity, it is assumed that the only cost associated with these regulations is the opportunity cost of all these resources spent by investors in relation to bureaucratic paper work; this cost is taken as exogenous by the agents and represents a deadweight loss to society. Instead, one could think of these regulations as taxes that are used by the government to provide public goods. This alternative assumption, however, would not alter the results obtained in the model as long as part of the costs paid by the investors represent a loss to society.

Given the regulations, the individuals can invest their resources in two different ways: they can follow the established government procedures and pay the costs associated with them, or they can pay a bribe θ to a corrupt government official who, in exchange, allows them to invest without any other requirement or delay. Thus, it is assumed here that the individuals are always able to find a corrupt official that is willing to engage in these activities without any real costs and that the amount of the bribe demanded is known by all agents.

The total amount of bribes collected at time t, R_t, is then redistributed among the consumers in a lump sum fashion, such that the rents from corruption received by individual i at time t, $r_{i,t}$, are given by

$$r_{i,t} = nR_t \cdot l_i^{\gamma}, \tag{4}$$

where $n = \dfrac{1}{\int_0^{\infty} l^{\gamma} \cdot f(l)dl}$ and γ are positive constants.

This specific form guarantees that $\int_0^{\infty} r_t(l) f(l) dl = R_t$ at all times and for all values of γ such that the γ^{th} moment of the distribution exists and is finite. Furthermore, it allows one to study the economy when the rents of corruption are distributed in a variety of ways, for a higher value of γ implies that a higher share of these rents go to the richer sectors of the population. A value of $\gamma = 0$, for example, implies that the rents of corruption are distributed equally among all individuals while a value of $\gamma = 1$ implies that these rents are distributed as a linear function of the individual's effective labor. As mentioned in the introduction, however, anecdotal evidence suggests a value of $\gamma > 0$.

In this way, corruption can affect the distribution of income both because it alters the incentives for investment and because it acts as a redistributive tax from the general public to the well connected. The assumption made about the allocation of the resulting bribery rents allows one to distinguish between these two effects and study them separately.

Define V_H as the maximum utility attainable by an individual i who does not pay the bribe, then

$$V_H = \max_{\{c_t, c_{t+1}\}} U(c_t, c_{t+1}) \tag{5}$$

$$\text{s.t.} \qquad l_i w_t + r_{i,t} = c_t + s_t + b\, s_t$$

$$s_t (1 + i_{t+1}) = c_{t+1},$$

$$r_{i,t} = n R_t l_i^{\gamma}$$

given w_t, i_{t+1}, $l_{i,}$, R_t, n and b.

Here b represents the share of the investment project that is lost because of the costs associated with the paper work required. These costs are assumed to increase with the size of the investment, reflecting the fact that bigger businesses may have a bigger cost of capital, are subject to more regulations as the scope of their actions becomes broader and are likely to incur in higher administrative costs before the permit is granted.

Similarly, define V_C as the maximum utility attainable by an individual i who pays the bribe θ, then

$$V_C = \max_{\{c_t, c_{t+1}\}} U(c_t, c_{t+1}) \tag{6}$$

$$\text{s.t.} \qquad l_i w_t + r_{i,t} = c_t + s_t + \theta$$

$$s_t (1 + i_{t+1}) = c_{t+1},$$

$$r_{i,t} = n R_t l_i^{\gamma}$$

given w_t, i_{t+1}, l_i, R_t, n and θ.

Here i_{t+1} represents the net real interest rate at time t+1 and the bribe θ is assumed to be the same for all investors. Moreover, since the individuals invest only when young, the bribe is paid only when young also, and it takes the form of a once and for all fixed payment.

Thus, the bribe θ acts as a "service charge" demanded by the official in exchange for his services, reflecting the empirical observations about the form of these bribes (Lowder (1989)) and the heavier burden of bribery for smaller investors (EBRD 1999). Throughout this section the value of θ is taken as exogenous, while in Section 3 this assumption is eliminated. A comparable way of modeling such fees has also been used by Norris (1998) and Ahlin (2000).

Thus, given the individual's endowment, he decides to pay the bribe as long as

$$\Omega \equiv (V_H - V_C) < 0. \tag{7}$$

The aggregate savings at time t by the agents of generation t, S_t, can then be expressed as the sum of the individual savings of both types of investors: those who follow government rules (H), and those who pay the fee and may overlook the regulations (C). That is,

$$S_t = \int_H s_t(i)di + \int_C s_t(i)di. \tag{8}$$

Finally, the specific form for the density function f(l) is obtained from the Dagum Type I cumulative density function defined as

$$F(x) = (1 + \lambda x^{-\delta})^{-\sigma}. \tag{9}$$

This specific function has been shown to fit actual income distributions remarkably well (see Dagum (1977)), and at the same time it provides closed form probability density and distribution functions[18]. As explained by Dagum and Lemmi (1989) and Dancelli (1986), the parameter λ is a parameter of scale, while the other two parameters (δ, σ) are inequality parameters. Specifically, Dancelli (1986) showed that the degree of inequality associated with this distribution is a strictly decreasing function of both δ and σ[19].

In addition, for the Dagum Type I density function, it can be demonstrated that all moments of order r about the origin exist for all values of r such that $r < \delta$ (see Dagum and Lemmi (1989)). Thus, in order for the values n and L_t to be finite it is necessary for the value of δ to be greater than one in the case of L_t, and greater than γ in the case of n. The empirical estimates available suggest a value of δ that is close to 4 and a value of γ below 1 (see Dagum and Lemmi (1989)).

A competitive equilibrium for this economy consists of a sequence of values $\{Y_t, K_t, L_t, i_t, w_t\}$ for $t \in (0,\infty)$, and set of individual's decision $\{c_t, c_{t+1}, s_t\}$ for $\{i, t\} \in (0,\infty)$; such that for these values the following conditions hold:

a. Given the values for θ and R, the individual decision rules solve maximization problems (5) and (6),
b. the competitive firms maximize profits,
c. all markets clear.

Specifically, since the capital market must clear in equilibrium, for all periods it must be true that

$$K_{t+1} = S_t, \tag{10}$$

where S_t represents aggregate savings by the young generation at time t as defined before.

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[18] The exponential density function was also used without altering the main results.

[19] Dancelli (1986) demonstrated this fact for the Gini coefficient associated with the Dagum Type I distribution.

2.1 Solution of the Basic Model

By solving the individual maximization problems (5) and (6), substituting the solution into (7), and simplifying the expressions one obtains the following:

$$V_H = \ln\left(\frac{l_i w_t + R_t l_i^{\gamma} n}{1+\beta}\right) + \beta \ln\left(\frac{\beta(1+i_{t+1})(l_i w_t + R_t l_i^{\gamma} n)}{(1+b)(1+\beta)}\right), \tag{11}$$

$$V_C = \ln\left(\frac{l_i w_t + R_t l_i^{\gamma} n - \theta}{1+\beta}\right) + \beta \ln\left(\frac{\beta(1+i_{t+1})(l_i w_t + R_t l_i^{\gamma} n - \theta)}{(1+\beta)}\right), \tag{12}$$

$$\Omega = (1+\beta)\ln[l_i w_t + R_t l_i^{\gamma} n] - (1+\beta)\ln(l_i w_t + R_t l_i^{\gamma} n - \theta) - \beta \ln(1+b). \tag{13}$$

The properties of the function Ω are important to the analysis since they determine the individual decision on whether to pay the fee or not.

Proposition 1: Given positive values for θ, R_t and w_t, at any time t there is a unique positive value of $l_i = l_t^*$ such that any individual with $l_i > l_t^*$ chooses to pay the bribe and any individual with $l_i < l_t^*$ chooses to pay the costs of investment associated with the regulations.

Proof: Using equation (13), at any time t one can find a value $l_i = l_t^*$ for which it is true that $\Omega = 0$, where this value of l_t^* is given by the following equation:

$$l_t^* w_t + R_t \cdot (l_t^*)^{\gamma} n = \frac{\theta(1+b)^{\beta/1+\beta}}{\left[(1+b)^{\beta/1+\beta} - 1\right]} \quad . \tag{14}$$

From equation (14) it follows that $l_t^* > 0$ for any $\theta > 0$. Furthermore, differentiating equation (13) with respect to l_i one obtains:

$$\frac{\partial\Omega}{\partial l_i} = \frac{(1+\beta)(w_t + \gamma R_t l_i^{\gamma-1} n)}{l_i w_t + R_t l_i^{\gamma} n} - \frac{(1+\beta)(w_t + \gamma R_t l_i^{\gamma-1} n)}{l_i w_t + R_t l_i^{\gamma} n - \theta} < 0 \qquad (15)$$

for all values of $\theta > 0$.

Given the consumers' decision rules and the value of l_t^*, the total rents collected at time t can be expressed as

$$R_t = \theta\,(1 - F(l_t^*)) = \theta\,[1 - (1 + \lambda (l_t^*)^{-\delta})^{-\sigma}]. \qquad (16)$$

Substituting equation (16) into (14), one can find a solution for l_t^* conditional on the value of w_t. Finally, with this solution one can obtain the level of aggregate savings S_t as

$$S_t = \int_0^{l_t^*} \frac{\beta(w_t l + R_t l^{\gamma} n)}{(1+b)(1+\beta)} \cdot f(l)dl + \int_{l_t^*}^{\infty} \frac{\beta(w_t l + R_t l^{\gamma} n - \theta)}{(1+\beta)} \cdot f(l)dl. \qquad (17)$$

Using the fact that product markets are competitive and the wage rate takes the value of $w_t = A\,(1-\alpha)\,K_t^{\alpha} L_t^{-\alpha}$, equations (10), (14), (16) and (17) provide a differential equation for the value of K_t. The corresponding phase diagram for this equation is illustrated in Figure 2 and suggests the existence of a unique positive steady state equilibrium[20] for the model. The nonlinear nature of these equations, however, makes it very difficult to obtain an analytical solution for the steady state of the economy and thus,

[20] The diagram in Figure 2 corresponds to the solution of the model with parameters $\gamma = 1$, $\alpha = 0.4$, $\beta = 0.95$, $\lambda = 1$, $\delta = 4$, $\sigma = 0.6$ and $b = 0.1$.

a numerical solution of the model that allows one to study the relevant comparative statics was found.

In order to perform the numerical analysis required, values for the exogenous parameters α, β, λ, A, σ, δ, and b must be chosen. Throughout all of the exercises presented here, the values of α and β were set equal to 0.4 and 0.95 respectively. The first one of these values is set to match the capital share of income in several countries as reported by Durlauf and Johnson (1995), while the second one is simply reflecting the consumer's preference for one unit of utility in the present relative to one unit of utility in the future. As for the values of λ and A, since they are scale parameters, they could be set to any number without altering the main results. Here, the value of λ was set equal to 1 and, for simplicity, the value of the total factor productivity constant A was set equal to the value of the constant L^{α} in a way such that the expression for the wage rate can be simplified even further to $w_t = (1-\alpha)\, K_t^{\alpha}$.

The income distribution parameters δ and σ were set equal to 4 and 0.6 respectively. The choices made for these parameters were based on several estimations described by Dagum and Lemmi (1989); as they pointed out, the estimates for the parameter δ "often take values in the neighborhood of four", while the estimates for the parameter σ were reported to be less than one in almost all of their regressions. Furthermore, the distribution can be shown to be unimodal for values of σ, δ such that the product $(\sigma\ \delta) > 1$. Here the value of σ was set equal to 0.6. A higher value of σ would yield a higher variance for the distribution, but would not alter the qualitative analysis presented below.

Finally, the value of b is set in line with the empirical estimations of the total costs of government regulations. Guasch and Hahn (1999), for example, reviewed the existent empirical estimates and reported the costs of governmental red tape and regulations to fall in the range of 7% to 19% of GDP for countries like Australia, Canada and the USA. Similarly, the average firm in the World Bank survey (1998) reported that between 25% and 50% of the senior's management time was dedicated to tasks related with the interpretation of government laws and regulations.

Although these numbers provide one with some idea about the value of b, their estimation is faced with many limitations and, therefore, it is important to consider several values for the parameter b. Throughout this section, the value of b is chosen to be 0.1; in Section 3, however, the analysis concentrates on the role of the costs imposed by the legal investment procedures, and the value of b is allowed to vary within a wider range.

Figures 3 and 4 describe two results obtained for the basic model. Here the parameter θ is allowed to vary within a range such that the resulting probability of an individual choosing to pay the bribe is close to zero for the highest value of θ and close to one for the lowest value. Within this range, the size of θ relative to the average income level of an individual stayed below 10%.

Figure 3 illustrates the changes in the steady state level of income per unit of effective labor as the exogenous level of bribe θ changes leaving all other parameters unchanged. When the bribe θ increases, more people decide not to pay the bribe and as a result, more resources are lost due to the costs incurred by honest investors. In addition, those individuals who keep paying the bribe see the share of their income available for investment diminished by the more expensive bribes. Thus, as shown in Figure 3, the corresponding level of income decreases as corruption (measured by the size of the bribe) increases.

Figure 4 illustrates the relationship between the bribe level and the income distribution measured by the coefficient of variation of the present value of total consumption expenditures. As the bribe becomes more expensive, two opposing effects take place and generate the non-monotonic relationship shown in this figure. On the one hand, the variance of the distribution decreases since only the richer individuals pay the new bribe while the poorer ones are directly unaffected by the change. On the other hand, the income level for the average individual is also decreasing relative to both the poorest and the richest persons and therefore, causes the coefficient of variation to increase.

Once θ has reached a certain level, the number of corrupt investors relative to honest ones becomes very small, and the loss of resources due to more agents having to incur in the time costs of regulations are minimal. Then, as shown in figure 4, the impact on the coefficient of variation caused by the decrease in the variance of the distribution dominates the effect of the lower average income level.

Changes in the value of the bribe θ that are independent of the costs of complying with bureaucratic procedures, like the ones studied so far, can be interpreted as the effect of other institutional variables like the administration of justice, general attitude of society towards corruption, etc. However, the anecdotal evidence suggests that the bribes charged by the officials depend importantly on the costs incurred by the investors were they not to pay the bribe. Thus, in order to incorporate this element, the next section treats the bribe θ as an endogenous variable and a function of b.

3. The Model with Endogenous Bribes

This section expands the basic framework presented before by considering the bribe as an endogenous variable in the model, while leaving all other aspects of the model unchanged. Specifically, corrupt officials are assumed to collude and act as one single official who chooses the level of bribe so as to maximize the total amount of rents produced by corruption R. This sort of collusive behavior has been observed in several instances (see for example Loaiza (2000)) and it reflects the fact that government officials in charge of implementing the regulations often work together in a single department for which each official's function is a complement to others.

As before, after solving the individual's maximization problem, the amount of total rents $R_t(\theta)$ can be expressed as:

$$R_t = \theta\,(1-F(l_t^*(\theta))) = \theta\,[1-(1+\lambda(l_t^*(\theta))^{-\delta})^{-\sigma}], \tag{18}$$

where the value of $l_t^*(\theta)$, now expressed as a function of θ, is given by equations (14) and (18) just as it was in the case of exogenous bribes. Thus, the corrupt officials' problem is reduced to choosing the value of θ so as to maximize the total rents collected; that is, he solves the following static problem:

$$\max_{\{\theta\}} \theta\,[1-(1+\lambda(l_t^*(\theta))^{-\delta})^{-\sigma}], \tag{19}$$

given λ, σ, δ and $l_t^*(\theta)$.

Differentiating equation (19) with respect to θ, one obtains the following first order condition for the corrupt official:

$$1-(1+\lambda(l_t^*(\theta))^{-\delta})^{-\sigma}-\theta\sigma\delta\lambda(1+\lambda(l_t^*(\theta))^{-\delta})^{-\sigma-1}(l_t^*(\theta))^{-\delta-1}\frac{dl_t^*(\theta)}{d\theta}=0, \quad (20)$$

where

$$\frac{dl_t^*(\theta)}{d\theta}=\frac{c-n(l_t^*(\theta))^{\gamma}[1-(1+\lambda(l_t^*(\theta))^{-\delta})^{-\sigma}]}{w_t+\theta\cdot n\{(\gamma(l_t^*(\theta))^{\gamma-1}[1-(1+\lambda(l_t^*(\theta))^{-\delta})^{-\sigma}]-\sigma\delta\lambda(l_t^*(\theta))^{\gamma-\delta-1}(1+\lambda(l_t^*(\theta))^{-\delta})^{-\sigma-1}\}}$$

is found by substituting equation (18) into (14) and totally differentiating the resulting expression. Here c is a constant that takes the value

$$c=\frac{(1+b)^{\beta/1+\beta}}{((1+b)^{\beta/1+\beta}-1)}. \quad (21)$$

Then, at any time t the equilibrium values $\{\theta_t^*, l_t^*(\theta_t^*)\}$ are given by the value of θ_t that satisfy equations (14), (18) and (20) simultaneously. Given these values one can obtain the level of aggregate savings S_t conditional of the wage rate w_t and the steady state level of income exactly as it was done in the previous section.

The results of the corresponding numerical exercises for this model are illustrated in Figures 5 through 8. Figure 5 presents the resulting steady state income levels for different costs of regulations b and different values for the parameter γ. As expected, the steady state income level is affected negatively by the amount of regulations. A reduction in the cost of regulations from 20% of gross investment to 10%, for example, leads to an increase in steady state income of approximately 0.9%. As before, the size of these changes is not altered importantly by the value of γ.

In Figure 5, when the cost b increases, the corrupt officials also increase the bribe θ in order to maximize total revenues from corruption. As a result, the level of aggregate income is affected negatively both because more resources are lost in the form of paper work costs and because investment becomes more expensive for those who pay the bribe. Here, in contrast with the exogenous bribe case presented in Section 2, the proportion of investors who pay the bribe remains roughly constant.

Figure 6 illustrates how an increase in the costs b causes an increase in the inequality of the income distribution measured by the coefficient of variation of total consumption expenditures. When b increases, the average income level of the economy decreases and causes the coefficient of variation to become greater than before. Simultaneously, since the rents of corruption are redistributed back to the consumers in an unequal fashion, as the public officials adjust the bribe θ upwards and the number of bribe payers remains constant, the variance of the distribution also increases. In this figure, an increase in the costs of regulations from 10% of gross investment to 20% leads to an increase in the coefficient of variation of about 10% for the case of $\gamma = 2$ and less for the other cases.

In fact, in both sections 2 and 3 the redistribution parameter γ has a notable impact on the aggregate income distribution independently of the extent of the costs b. By keeping the cost b constant at 0.2 and increasing the parameter γ from 1 to 2, for example, the coefficient of variation grows from 0.451 to 0.526, a change of almost 17%. Such result cannot be overlooked, since it suggests that a large part of the distributional consequences of corruption is due to the lack of adequate and equitable access to political power alone.

Figure 7 illustrates how the level of corruption measured by the size of the bribe increases when the cost of regulations b increases. As explained before, higher regulations motivate the officials to charge a higher θ since the number of investors willing to avoid the regulations becomes higher. This result matches the positive correlation between the level of corruption and the time costs of government regulations that was reported by Gray and Kaufmann (1998) and that was also illustrated by the survey data presented in Figure 1.

Finally, Figure 8 shows the relation between the steady state level of income and the redistribution parameter γ while leaving all other parameters unchanged. As the parameter γ increases, the resulting rents from corruption concentrate even more in the hands of a reduced group. As a result, two opposite effects on the level of income take place: On the one hand, less people are willing to pay the bribe and more resources are lost in bureaucratic procedures, thus affecting the steady state level of income negatively. On the other hand, bigger values for γ affect the steady state level of income positively as richer individuals, who have higher incentives to invest, capture most of the corruption rents. As shown in the figure, the second effect dominates the first one for big enough values of γ.

4. Conclusions and Future Research

The corruption phenomena can take many forms and each one of these can have separate and distinguished effects on the aggregated variables of the economy. The kind of corruption addressed here refers mainly to the bribes paid by economic agents in order to avoid the costs generated by bureaucratic regulations and procedures. This kind of corruption has been reported frequently in several regions of the world and has become part of every day life for many.

By imposing numerical values for the model's parameters and simulating the comparative statics, this paper provides important intuition about the aggregate economy that cannot be obtained empirically given the significant constraints imposed by the limited data available on income inequality, bureaucratic inefficiency, and corruption. The results obtained throughout the previous sections suggest that the combination of cumbersome regulations and widespread bribery can alter both the creation and the distribution of wealth in an important manner. Moreover, the results revealed the distribution of corruption rents as one of the key elements on the problem.

In the future, the creation of adequate data sets that allow one to distinguish between the different sources as well as the different kinds of corruption will be, without a doubt, an important task of research. On the theoretical side, other ways of modeling corruption need to be explored; specifically, the kind of corruption involving theft of a public asset, which seems to be quite common in many countries.

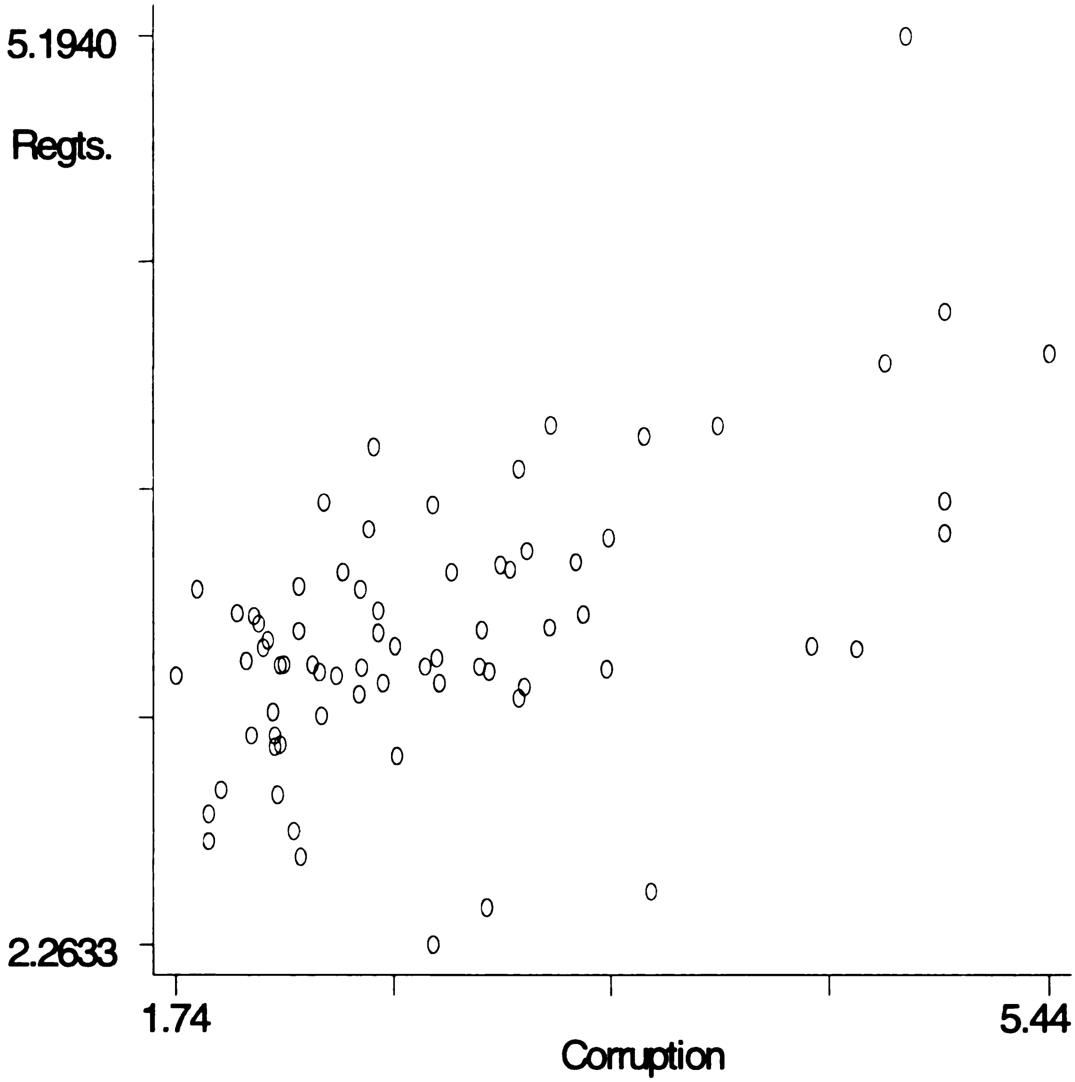

Figure 1: The Level of Corruption vs. the Cost of Government Regulations

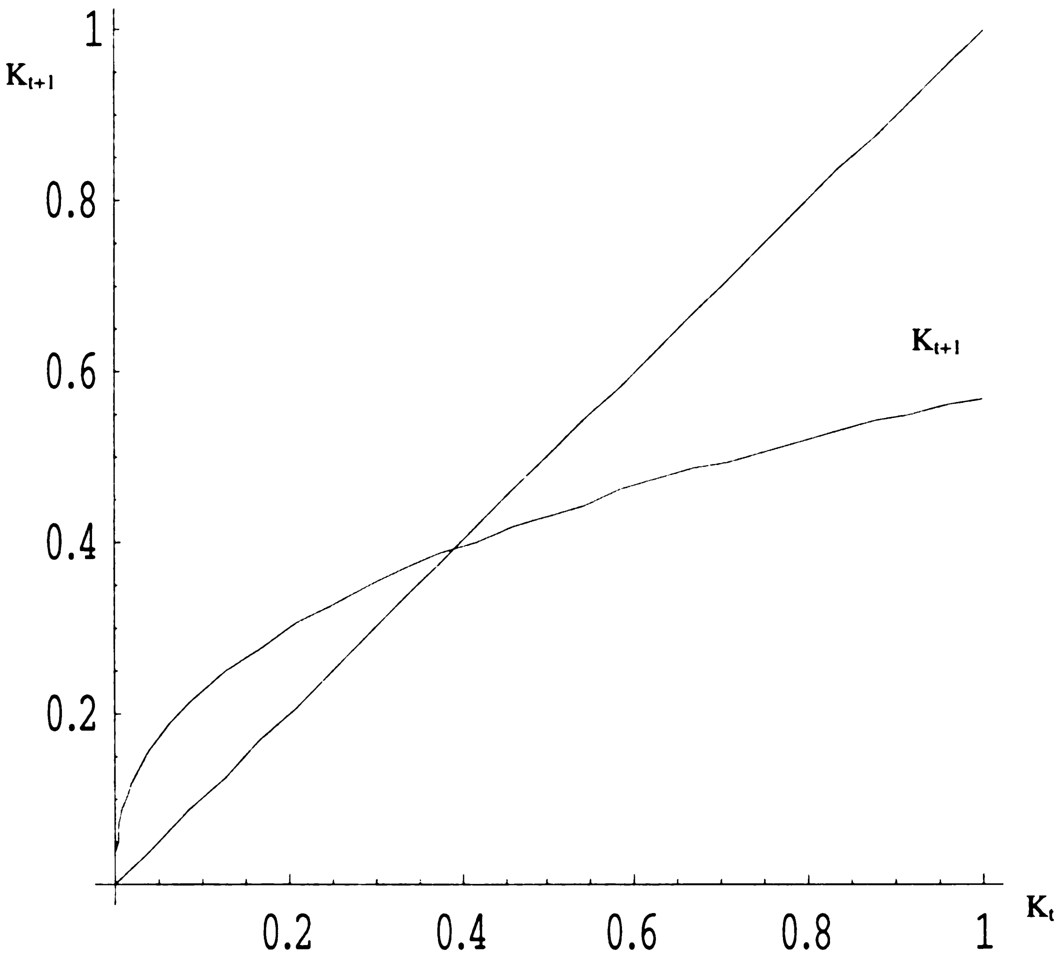

Figure 2: Phase Diagram for Capital Accumulation.

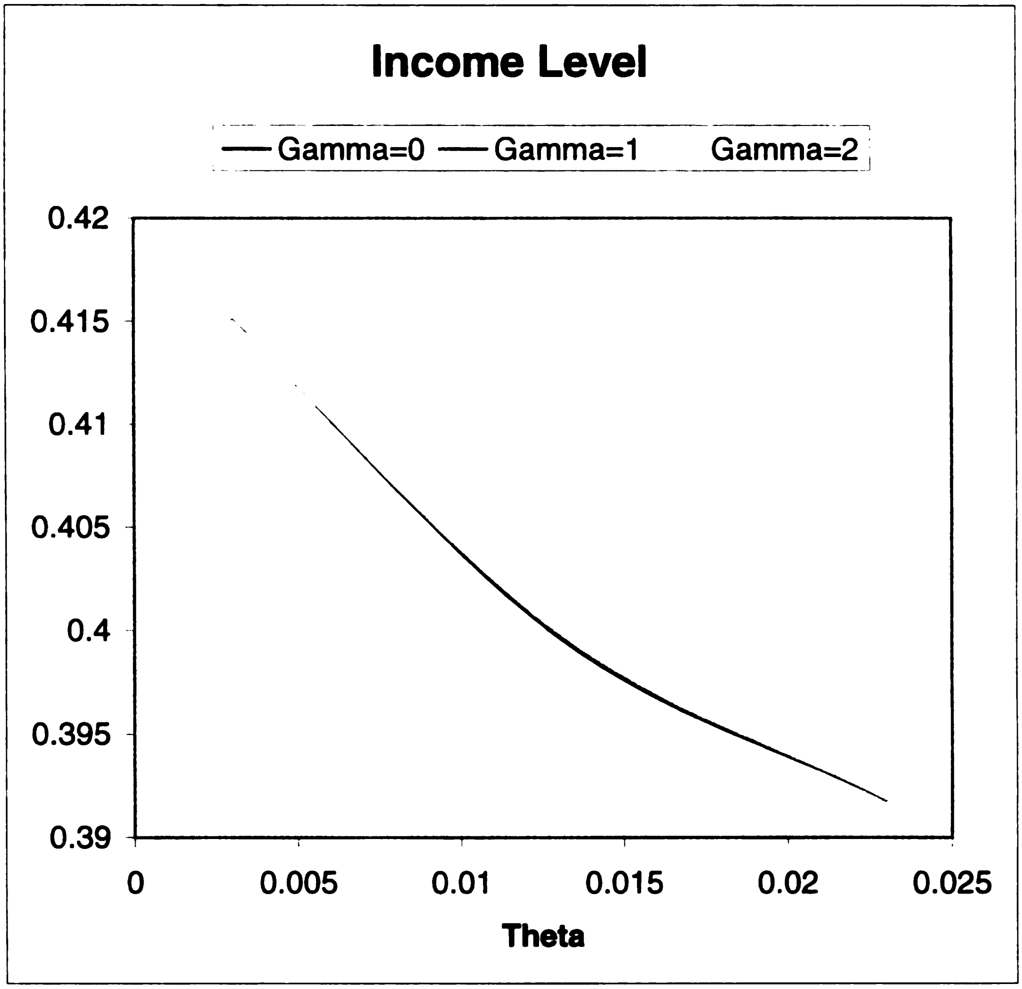

Figure 3: Steady State Income Level per Unit of Effective Labor.

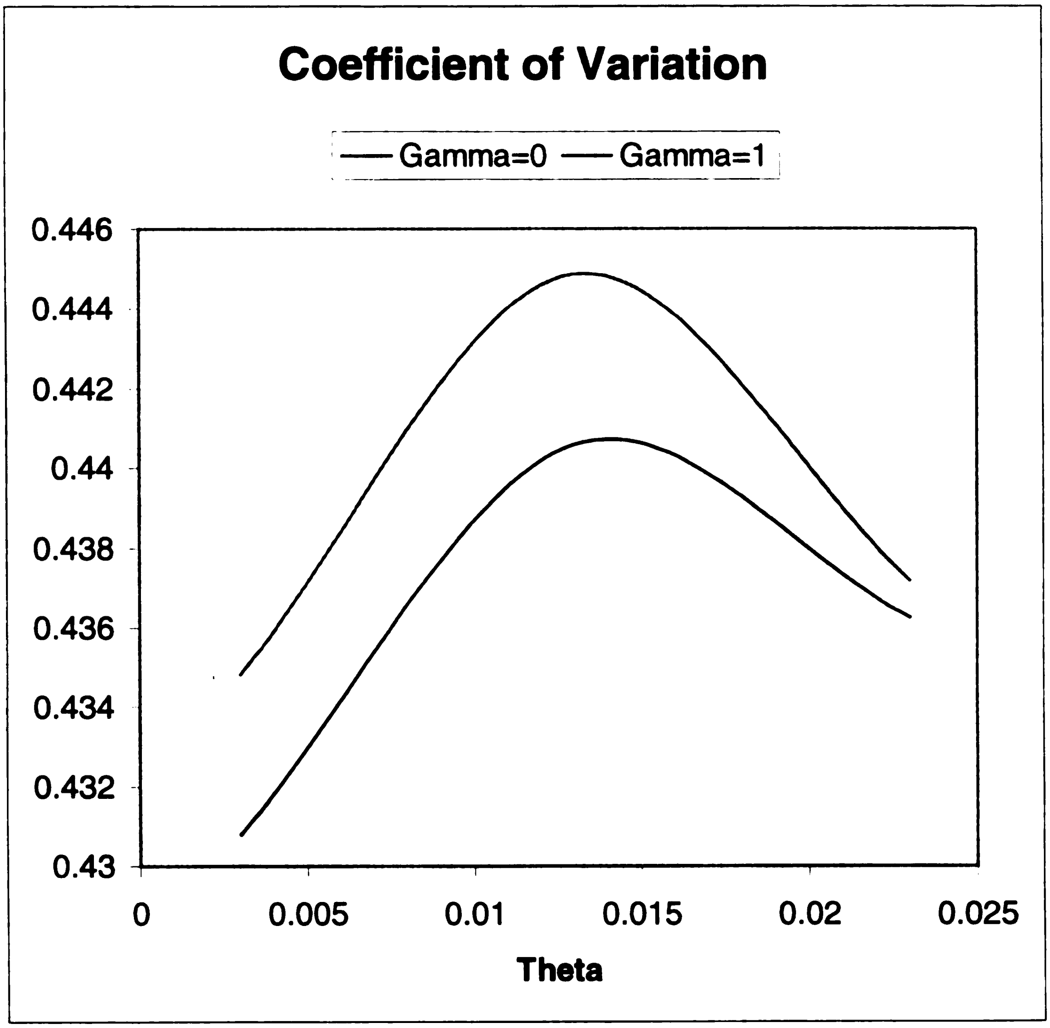

Figure 4: Steady State Coefficient of Variation for Total Consumption Expenditures.

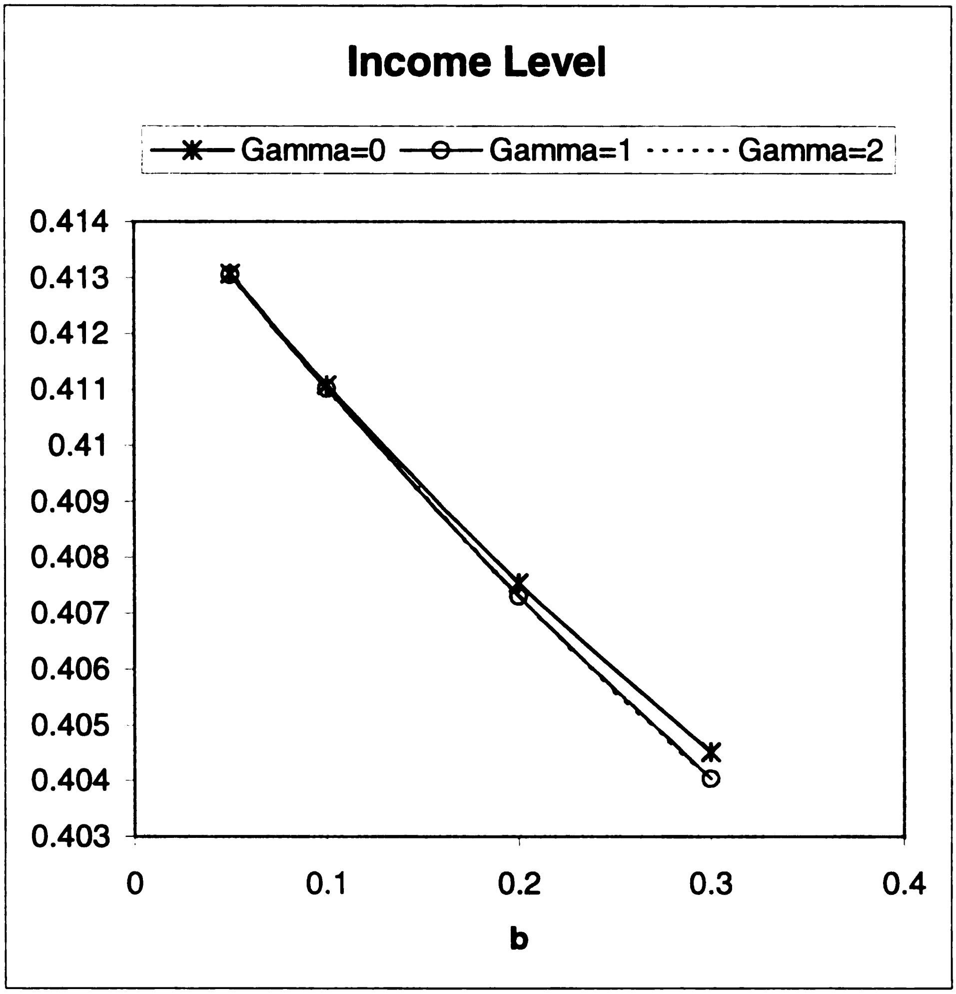

Figure 5: Steady State Income Level per Unit of Effective Labor. The Case of Endogenous θ.

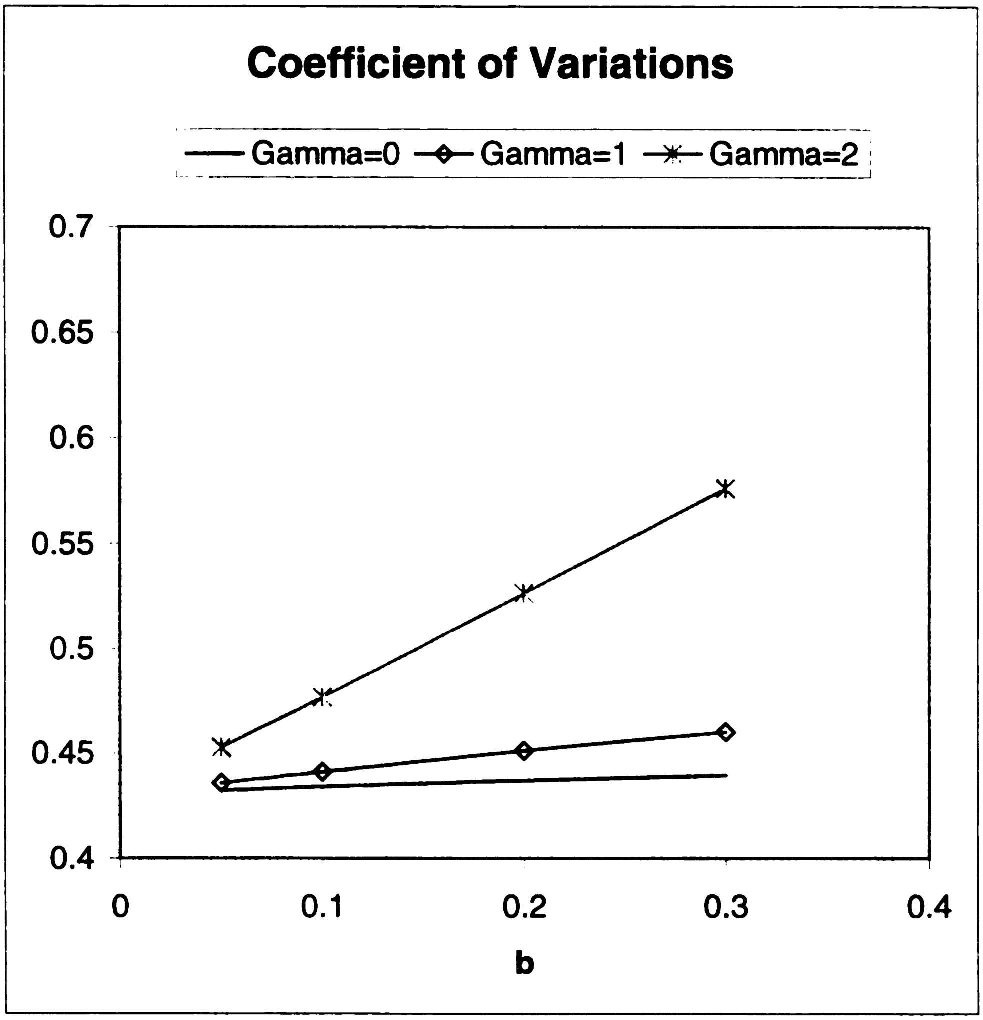

Figure 6: Steady State Coefficient of Variation for Total Consumption Expenditures. The Case of Endogenous θ.

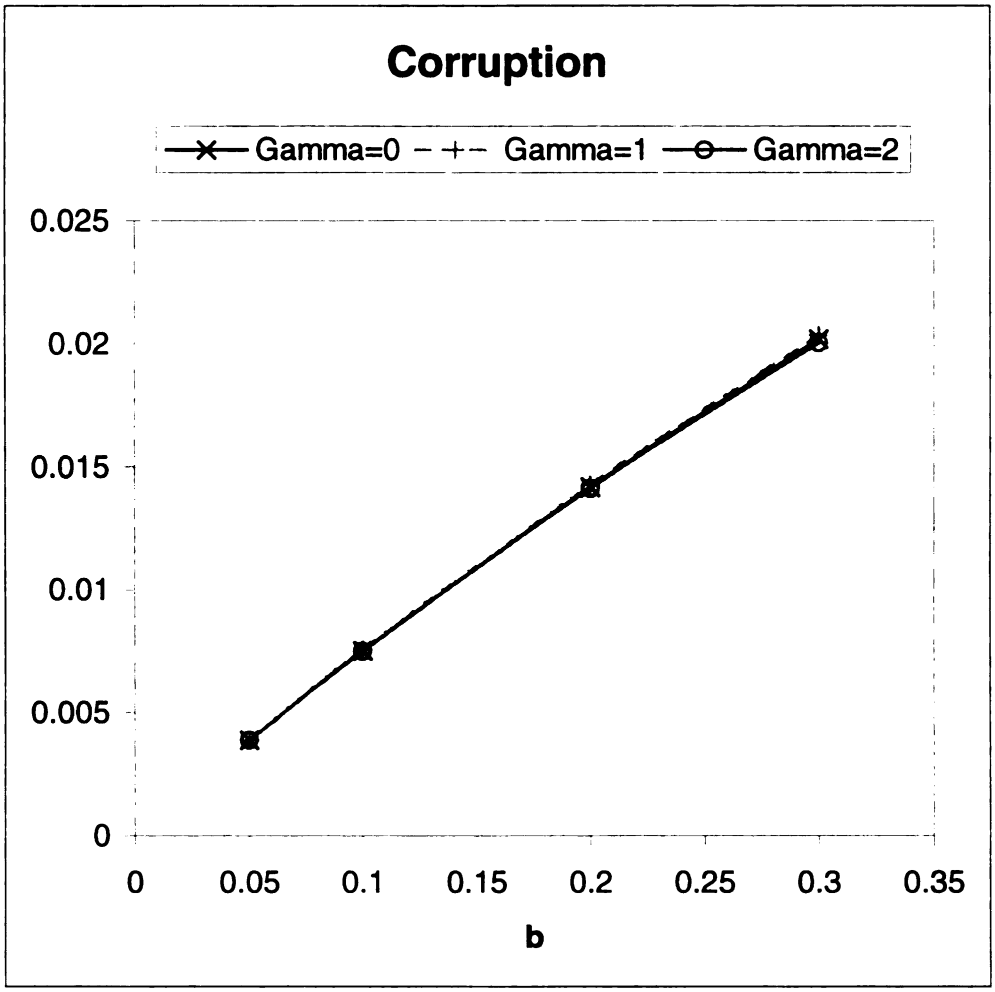

Figure 7: The Level of Corruption as a Function of the Costs of Bureaucratic Rules.

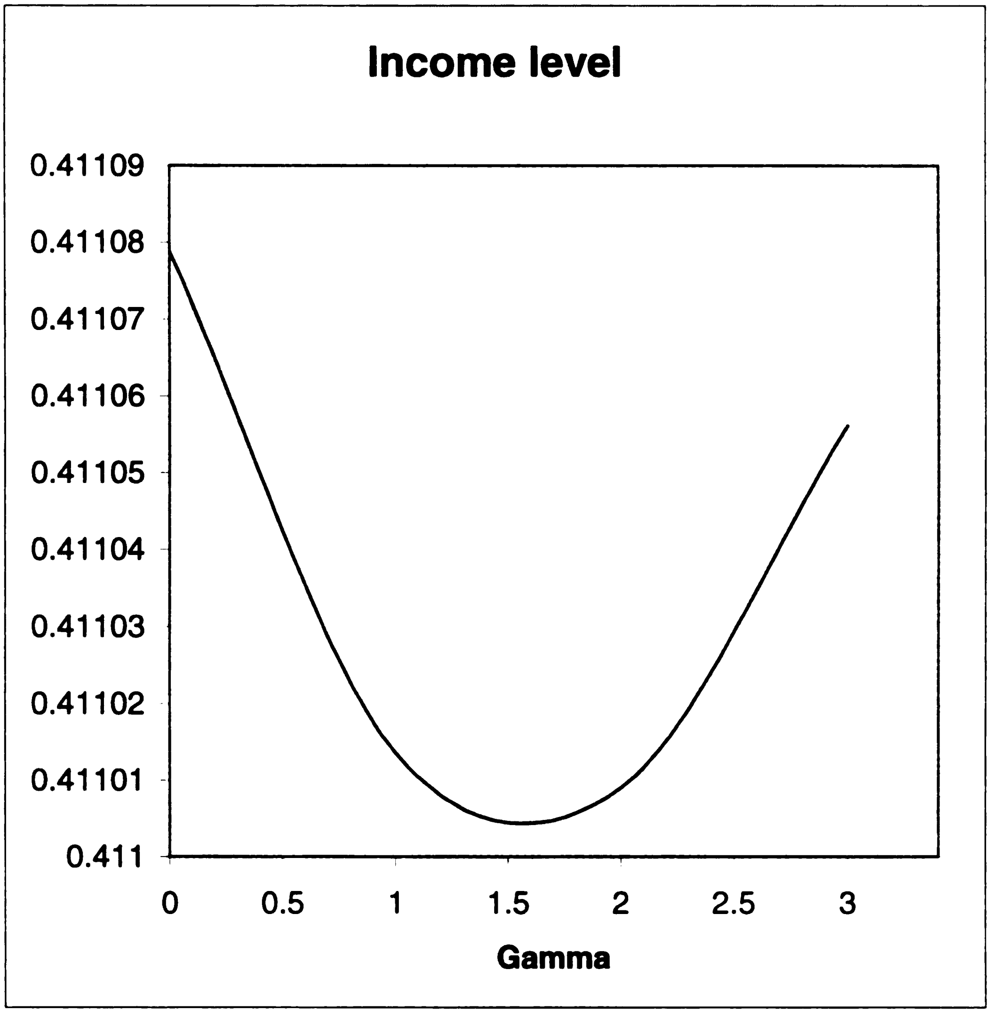

Figure 8: Steady State Level of Income for Different Values of the Redistribution Parameter γ.

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CHAPTER 3

PRIVATIZATION, DEREGULATION AND CAPITAL ACCUMULATION

1. Introduction

Since the early 1980's, many countries have privatized and deregulated intermediate goods industries like gas, electricity or telecommunications that had traditionally been run by the government. These policy reforms are described by Newberry (1997), Parker (1998), and Kikery, Nellis and Shirley (1994). The European Union, for example, has adopted aggressive policies towards the elimination of all monopolies in the telecommunication market and has conducted a general privatization program whose sales receipts amounted to more than 3% of total GDP between 1985 and 1995 (Constantinou and Lagoudakis (1996), Parker (1998)). In other regions of the world, countries like Australia, Chile, Brazil, Argentina and the United States have implemented similar policies (Winston (1993), Van der Vlies (1996), Vickers and Yarrow (1991)).

Evidence from specific industries shows that these state-to-market transitions are usually followed by increased production levels and productive efficiency. In Australia, for instance, one year after the dissolution of the government monopoly over the provision of telecommunications services and the introduction of competition, the cellular mobile market alone had grown by 200% in total sales, while the total telecommunications sector grew by 9% during the same period (Van der Vlies (1996))[21]. In the case of England, total factor productivity of the electricity and telecommunications industries increased approximately 60% relative to the whole manufacturing sector after the government privatized these public utilities and allowed the entry of competitors (Bishop and Thompson (1992), Price and Weyman-Jones (1996), Newberry (1997)).

The increased production levels experienced after such reforms have been attributed to two main factors: first, increased competition provided by free market entry is expected to improve allocative efficiency of resources, to decrease prices and to improve monitoring possibilities (Vickers and Yarrow (1991)). Second, the change from public to private ownership might make investment decisions more flexible and may also improve the incentives for productive efficiency (Kay and Thompson (1986), Plane (1992), (1997)).

The empirical evidence on the relationship between privatization and productivity is mixed and, so far, there are no definite conclusions on whether privatization alone (without free market entry) has an impact on productivity (see for example Kay and Thompson (1986), Cook and Kirkpatrick (1988), and Domberger and Pigott (1994)). In contrast, most empirical studies agree that the presence or absence of competition may be an important determinant of a firm's economic performance even when such firms are government owned (Domberger and Pigott (1994), Wallsten (1999)). Yet, as pointed out by Kay and Thompson (1986), it is difficult to distinguish empirically whether any changes in productive efficiency are caused by privatization or by increased competition. Part of the difficulty, at least, arises because both privatization and market liberalization usually occur together within a short time period.

To the extent that energy or telecommunications are complementary to either physical or human capital, it is expected that any changes in their aggregate level of output, or in their productive efficiency, would also have an impact on the rate of growth

[21] Stoetzer and Tewes (1996) report a similar experience for the German cellular telephony market.

of the economy. Stern (1993), for example, shows that energy use and quality can be a limiting aspect for economic growth, and that any factors that cut energy use would also reduce aggregate income levels. At the business cycle frequencies Hamilton (1983,1996) show that oil shocks have a substantial impact on aggregate output. Thus, understanding the different aspects of such state-to-market transitions is of most importance for all those countries that experience them.

This paper presents a model of capital accumulation under three alternative scenarios: one where the intermediate sector is composed of a public monopoly under government control, one where the intermediate sector is dominated by a private monopoly, and one with a competitive intermediate sector. Here, a regime change from a public monopoly system to a private monopoly one will be referred to as privatization, whereas a regime change that introduces competition into a previously monopolistic market will be referred to as a deregulation of that market.

We use this model to analyze some of the general equilibrium implications of state-to-market transitions and examine separately the consequences of both, privatization of public enterprises and deregulation of intermediate markets. In doing this, we abstract completely from any changes due to productivity differences between public and private firms. That is, we assume that all firms have access to the same production technology.

The following section describes the theoretical models and defines the equilibrium for the economies. Sections 3 and 4 present the solutions to the model and analyze the results. Finally, Section 5 contains the conclusions and the directions for future research.

2. The Model

The economy is populated by a large number of individuals, which we set equal to one. The individual lives forever and is endowed with k_0 units of capital at time zero and with one unit of labor in each period. At each point in time, he supplies labor inelastically in exchange for the before-tax wage rate w and supplies as many units of capital as he has in exchange for the before-tax rental price of capital q. The individual's lifetime utility function takes the form

$$\sum_{t=0}^{\infty} \beta^t \left(\frac{c_t^{1-\sigma}}{1-\sigma} \right),$$

where β is the discount factor, c_t represents consumption of final goods at time t and $1/\sigma$ is the elasticity of inter-temporal substitution. Every period the individual divides his total income between consumption at period t, c_t and investment at period t, i_t. In addition, it is assumed that every period all units of capital depreciate at the rate δ regardless of the specific use to which they are put.

Two goods are produced in this economy: a final good Y_t that is used for consumption and an intermediate good E_t that is used completely in the production of final goods. In this sense, the role of E_t is similar to the role of many intermediate goods like electricity, gas, coal, or general energy that are used in almost all production processes. For simplicity, we assume that this intermediate good is not consumed directly by the individuals.

The final good is produced competitively by a large number of firms that use the same constant returns to scale technology, which is given by

$$Y_t = A(\theta K_{F,t}^{\rho} + (1-\theta)E_t^{\rho})^{\alpha/\rho} N_{F,t}^{1-\alpha}. \qquad (1)$$

Here $K_{F,t}$ and $N_{F,t}$ represent the amount of capital and labor used in the production of final goods at time t respectively, A is a constant measuring total factor productivity and ρ and α are constants that measure the degree of substitutability and the marginal products of the factors in the production function. Since the technology exhibits constant returns to scale, we can assume that there is one firm and that Y_t is aggregate output.

At the same time, the intermediate good E is produced using the constant returns to scale technology

$$E_t = K_{I,t}^{\gamma} N_{I,t}^{1-\gamma}, \qquad (2)$$

where $K_{I,t}$ and $N_{I,t}$ represent the total units of capital and labor used in the production of intermediate goods at time t respectively, and γ is a positive constant. As explained before, this intermediate good is assumed to be produced under three alternative regimes: public monopoly, private monopoly and perfect competition. Notice that since the production function in equation (2) exhibits constant returns to scale we abstract from any natural monopoly issues. In this model there are thus no efficiency reasons at all for a public or a private monopoly.

In the public monopoly case, we assume the government captures any positive profits π_g generated by the intermediate industry and uses them in the same way as any other type of revenue. In the case of a private monopoly, we assume that any positive profits obtained by the firm, π_p, are distributed equally among the individuals. Finally, when the intermediate industry behaves competitively there are no profits.

The government in these economies taxes labor and capital income at the common rate τ. This tax rate is exogenous and assumed to be constant over time. In the perfect competition and private monopoly cases, we assume that total taxes collected are redistributed back to the consumers in the form of a lump-sum transfer T. In the case of the public monopoly, total taxes collected together with public monopoly profits π_g are used in order to finance the public capital investment. Specifically, we assume that a fraction ψ of total government revenues is used to finance investments in capital for the public firm and the rest is redistributed back to the consumers in the same fashion as before. In addition, we assume that the government budget is balanced in each period.

The representative final goods firm's problem can be expressed as

$$\max_{\{K_F, N_F, E\}} F(K_{F,t}, E_t, N_{F,t}) - q_t K_{F,t} - r_t E_t - w_t N_{F,t} \tag{3}$$

$$\text{s.t. } F(K_{F,t}, E_t, N_{F,t}) = A(\theta K_{F,t}^{\rho} + (1-\theta)E_t^{\rho})^{\alpha/\rho} N_{F,t}^{1-\alpha},$$

given q_t, r_t and w_t,

where r_t represents the price per unit of intermediate good E at time t, and the firm takes all prices as given. Similarly, the individual's utility maximization problem can be expressed as

$$\max_{(c_t, i_t)_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t \left(\frac{c_t^{1-\sigma}}{1-\sigma} \right) \tag{4}$$

$$\text{s.t. } \sum_{t=0}^{\infty} p_t \, [(1-\tau)(q_t k_t + w_t) + T_t + \pi_{p,t}] = \sum_{t=0}^{\infty} p_t \, [c_t + i_t] \text{ and}$$

$$k_{t+1} = (1-\delta)\, k_t + i_t ,$$

given T_t, $\pi_{p,t}$, w_t, q_t, p_t, τ and k_0.

Here p_t represents the price of a unit of consumption at time t relative to a unit of consumption at time t +1, and $\pi_{p,t}$ equals zero except in the private monopoly case. Since population size is normalized to unity, individual capital stocks and individual consumption are equal to aggregate levels. From now on, we will use upper case letters to denote both.

Finally, in equilibrium the capital and labor markets must clear, that is to say, at all times it must be true that

$$K_t = K_{F,t} + K_{I,t}, \tag{5}$$

$$1 = N_{F,t} + N_{I,t}\,. \tag{6}$$

Then, the model is solved under the three alternative specifications for the market structure of the intermediate sector. Subsections 2.1, 2.2 and 2.3 describe the economy under these alternative scenarios and provide the definition of equilibrium for each case respectively.

2.1 The Case of Public Monopoly Intermediate Sector

We chose to model the public monopoly case as a monopolist who maximizes profits, given an exogenous amount of capital that is determined by the government's investment I_G. While the objective function of public sector enterprises is by no means uncontroversial, we assume that the public firm's objective is to maximize profits. This provides a convenient comparison to the case of a private monopoly and to the case of competitive markets, where profit maximization is more natural. Specifically, we assume that

$$K_{I,t} = (1-\delta)\, K_{I,t-1} + I_{G,t}. \tag{7}$$

As mentioned before, government investment in public capital $I_{G,t}$ is modeled as a fixed fraction ψ of total government revenues at time t, which are given by the sum of total tax revenues and total monopoly profits at time t. That is,

$$I_{G,t} = \psi\, [\pi_{g,t} + \tau\, (q_t\, K_t + w_t)]. \tag{8}$$

The remaining fraction $(1-\psi)$ of the government revenues is redistributed back to the consumers as the lump sum transfer T.

Given these assumptions, the public monopolist's problem can be expressed as

$$\max_{\{N_I\}} r(E_t) \cdot E_t - w_t N_I \tag{9}$$

$$\text{s.t. } E_t = K_{I,t}^{\gamma} N_I^{1-\gamma},$$

given $r(E_t)$, $K_{I,t}$, w_t, q_t.

Here, the inverse demand function for the intermediate good $r(E_t)$ corresponds to the representative final good firm's input demand function resulting from its maximization problem as stated by (3).

The corresponding equilibrium for this economy is defined as a sequence $(C_t, K_t, E_t, Y_t, q_t, r_t, w_t, T_t, \pi_{g,t})_{t=0}^{\infty}$, such that

i. the individuals solve their utility maximization problem as given by (4),

ii. the final good firms solve their profit maximization problem as given by (3),

iii. the monopolist solves his maximization problem as given by (9),

iv. the government budget is balanced in all periods, and

v. all markets clear.

2.2 The Case of Private Monopoly Intermediate Sector

This alternative scenario presents two important variations with respect to the one presented in section 2.1. First, the intermediate sector production is now conducted by a private monopoly. Second, the amount of capital used by the intermediate firm is no longer determined by public investment but by the firm itself. Thus, the monopolist's problem can be written as

$$\max_{\{N_I, K_I\}} \; r(E_t)\cdot E - w_t N_I - q_t K_I \tag{10}$$

$$\text{s.t. } E_t = K_I^{\gamma} N_I^{1-\gamma},$$

given $r(E_t)$, w_t, q_t;

where the inverse demand function $r(E_t)$ is identical to the one used in the public monopoly case.

The corresponding equilibrium for this economy is defined as a sequence $(c_t, K_t, E_t, Y_t, q_t, r_t, w_t, T_t, \pi_{p,t})_{t=0}^{\infty}$, such that:

i. the individuals solve their utility maximization problem as given by (4),

ii. the final good firms solve their profit maximization problem as given by (3),

iii. the monopolist solves his maximization problem as given by (10),

iv. the government budget is balanced in all periods, and

v. all markets clear.

2.3 The Case of Perfect Competitive Intermediate Sector

Since the intermediate good technology exhibits constant returns to scale, there is no natural monopoly case. We thus can allow this sector to be competitive. When the intermediate good is produced by a number of competitive firms, the representative intermediate good firm's problem can be written as

$$\max_{\{N_I, K_I\}} r_t \cdot E_t - wN_I - q_t K_I \tag{11}$$

$$\text{s.t. } E_t = K_I^{\gamma} N_I^{1-\gamma},$$

given r_t, w_t, q_t.

Then, an equilibrium for this economy can be defined as a sequence $(c_t, K_t, E_t, Y_t, q_t, r_t, w_t, T_t)_{t=0}^{\infty}$, such that:

i. the individuals solve their utility maximization problem as given by (4),

ii. the final good firms solve their profit maximization problem as given by (3),

iii. the intermediate good firms solve their maximization problem as given by (11),

iv. the government budget is balanced in all periods, and

v. all markets clear.

3. Solution of the Model: The Cobb-Douglas Case

For a value of ρ arbitrarily close to zero, the production function described by equation (1) can be approximated by the simpler Cobb-Douglas technology

$$Y_t = AK_{F,t}^{\alpha} E_t^{\varphi} N_{F,t}^{1-\alpha-\varphi}. \tag{12}$$

This special case is useful to start with, since it allows us to obtain closed form solutions for the model and it provides us with important intuition that can also be used to understand the more general cases.

Solving the consumer's dynamic utility maximization problem and the final good firm's profit maximization problem we obtain the Euler equation for the consumer and the first order conditions for the firm. These equilibrium conditions are stated in equations (13)-(16) respectively.

$$\left(\frac{c_{t+1}}{c_t}\right)^{\sigma} = \beta(q_{t+1}(1-\tau)+(1-\delta)) \tag{13}$$

$$q_t = \alpha A K_{F,t}^{\alpha-1} E_t^{\varphi} N_{F,t}^{1-\alpha-\varphi} \tag{14}$$

$$w_t = (1-\alpha-\varphi) A K_{F,t}^{\alpha} E_t^{\varphi} N_{F,t}^{-\alpha-\varphi} \tag{15}$$

$$r_t = \varphi A K_{F,t}^{\alpha} E_t^{\varphi-1} N_{F,t}^{1-\alpha-\varphi} . \tag{16}$$

Throughout the rest of the paper, we will focus on steady states and drop time subscripts whenever possible without the risk of confusion.

Furthermore, after solving the intermediate firm's profit maximization problem for the three alternative scenarios in question we obtain additional first order conditions in each case. Equations (17)-(21) describe these first order conditions for the cases of public monopoly, private monopoly and competition respectively. In the case of public monopoly, we obtained only one first order condition for the amount of labor used in the production process since capital investment is financed out of tax revenue and capital is made available to the firm free of charge.

$$w = A(1-\gamma)\varphi^2 K_F^{\alpha} N_F^{1-\alpha-\varphi} K_I^{\gamma\varphi} N_I^{(1-\gamma)\varphi-1} . \tag{17}$$

For the case of private monopoly, an additional condition is obtained regarding the amount of capital used, thus yielding

$$w = A(1-\gamma)\varphi^{2} K_{F}^{\alpha} N_{F}^{1-\alpha-\varphi} K_{I}^{\gamma\varphi} N_{I}^{(1-\gamma)\varphi-1}, \tag{18}$$

$$q = A\,\gamma\varphi^{2} K_{F}^{\alpha} N_{F}^{1-\alpha-\varphi} K_{I}^{\gamma\varphi-1} N_{I}^{(1-\gamma)\varphi}. \tag{19}$$

Similarly, for the perfect competition scenario the first order conditions are:

$$w = r(1-\gamma)K_{I}^{\gamma} N_{I}^{-\gamma}, \tag{20}$$

$$q = r\gamma K_{I}^{\gamma -} N_{I}^{1-\gamma}. \tag{21}$$

The system composed of equations (2), (12), (13)-(16), (20) and (21) can be solved in order to obtain the steady state equilibrium for the economy with a competitive intermediate sector; similarly, solving equations (2), (12), (13)-(16), (18) and (19) simultaneously, the steady state equilibrium for the economy with a private monopoly intermediate sector is found. Finally, the corresponding steady state equilibrium for the public monopoly case is obtained by solving equations (2), (7), (8), and (12)-(17). Table 1 provides the closed form solutions of these systems of equations for the most relevant variables in the model.

The analytical comparison of the model's outcome under the alternative market structures does not allow us to reach definitive conclusions about the performance of the public monopoly relative to the other regimes. Thus, a numerical exercise was conducted where the exogenous parameters of the model are identical in all cases and the fraction ψ of government revenues destined towards public investment is allowed to vary.

The specific amount of public investment on intermediate industries differs significantly within a short period of time and across countries. Yet, the empirical observations suggest a value of ψ that is very close to zero and even negative. The net financial flow from the central government to all state-owned enterprises as reported for several economies by the World Bank indicators, for example, averaged –0.97 % of G.D.P between 1990 and 1997 and 0.08 % of GDP for the period 1985-1990 [22].

Table 1 lists the parameter values chosen throughout all the computational experiments in this section. For the parameter γ, the share of capital in the value of the intermediate input, a value of 0.4 was chosen; this value is in line with the empirical observations about the role of capital in the production of several intermediate goods. In the case of Britain, for example, Bishop and Thompson (1992) reported capital to constitute 40.2% of total inputs used in the production of electricity, 44.4% in the production of gas, and 46.7% for the telecommunication industry. Other values for this parameter were also considered without altering the qualitative properties of the results.

Because specific data for the parameter φ, which measures the income share of the intermediate good E, is difficult to obtain[23], we performed the calculations under different values for this parameter. Since before the 1990's it was common for the government to control the production of intermediate goods like public utilities and telecommunications, a logical upper bound for φ is the total economic activity of all state-owned enterprises as a percentage of GDP during this same period.

The average estimate of this ratio, as reported in the World Bank's World Development Indicators, was 0.099 during the period 1985-1990 and 0.11 during 1990-

[22] The sample consists of 23 countries for the 1985-1990 period and only of 8 countries for the 1990-1997 period. Countries were included based on the availability of the relevant information. The countries in the first period are: India, Indonesia, Kenya, Republic of Korea, Malawi, Mauritus, Mexico, Morocco, Namibia, Panama, Paraguay, Peru, Rwanda, Senegal, Sierra Leone, Sri Lanka, Thailand, Togo, Trinidad and Tobago, Tunisia, Turkey, Uruguay and Venezuela. The countries in the second period are: Indonesia, Mexico, Panama, Paraguay, Peru, Sri Lanka, Thailand and Turkey.

1997[24]. For our purposes, the parameter φ was allowed to range between 0.05 and 0.3. The choice of values for the parameters α, δ, and β is perhaps uncontroversial. Setting A = 1 is simply a normalization, while a value of $\tau = 0.2$, corresponds to government's share of GDP in relatively poor countries.

Figures 1- 4 use these different values of φ and compare the resulting steady state income levels for the three market structures as the value of ψ increases. As shown in all of these figures, for most values of ψ a public monopoly results in levels of income superior to that ones of a private monopoly but inferior to that ones of perfect competition. Only when the share of public revenues going to public investment (ψ) was set very close to zero (from 0.05 in Figure 4 to 0.0017 in Figure 1) did the private monopoly case produce a higher income level than the public monopoly one.

The differences in the steady state income levels among the three regimes are substantial. In Figure 1, for a value of $\psi = 0.05$, for example, the steady state income level resulting from a public monopoly is approximately 6.8% lower than the one resulting from the perfect competition case and 10% higher than that from the private monopoly case.

Similar exercises are conducted in Figures 5 and 6 for the price of intermediate goods and the wage rate respectively. As shown there, the wage rate in a public monopoly regime is in most cases higher than the one resulting from a private monopoly and always lower than the one from competition; similarly, the price of the intermediate good is lowest in the case of competition and highest in the case of private monopoly for

[23] See Plane (1992) for a more detailed explanation of the limited available sources of data.

big enough values of values of ψ. Figures 5 and 6 were constructed using a value of 0.05 for the parameter φ; however, similar results were obtained when using other values.

These results imply that countries involved in state-to-market transitions are likely to benefit from the introduction of competition under most circumstances, but will gain from privatization alone only if the fraction of tax revenues destined towards public investment was close enough to zero before the change. Even when public investment is close to zero, the income gains from privatizing a public monopoly without allowing for competition are small compared to those obtained when competition is introduced.

4. The General CES Technology Case

Although working with a Cobb-Douglas technology in Section 3 simplified the analysis and provided a useful benchmark for other specifications, it may not be the case that the elasticity of substitution between physical capital and the intermediate good approaches one. In fact, it is possible that these factors of production act as complements instead of substitutes. In this section, in order to overcome such limitations, we solve the model for the more general CES technology as specified by (1).

In this case, the first order conditions coming out of the final good firm's maximization problem are

$$q = A\alpha\theta K_F^{\rho-1} N_F^{1-\alpha} [\theta K_F^{\rho} + (1-\theta)E^{\rho}]^{\alpha-\rho/\rho}, \qquad (22)$$

[24] Their estimation is based on the value added of state-owned enterprises that generated most of their revenue by selling goods and it excluded public services like education and health services that are financed from the government's revenue

$$w = A(1-\alpha)N_F^{-\alpha}[\theta K_F^\rho + (1-\theta)E^\rho]^{\alpha/\rho}, \tag{23}$$

$$r = A\alpha(1-\theta)E^{\rho-1}N_F^{1-\alpha}[\theta K_F^\rho + (1-\theta)E^\rho]^{\alpha-\rho/\rho}. \tag{24}$$

Similar to the Cobb-Douglas case, in order to solve the profit maximization problem for the intermediate firm under the three alternative scenarios, we use equation (24) as the conditional demand function for the intermediate good E. The resulting first order conditions from the respective problems are given below. As before, only one condition is obtained in the public monopoly case:

$$w = \left[A\alpha(1-\theta)(1-\gamma)\rho N_F^{1-\alpha}N_I^{(1-\gamma)\rho-1}K_I^{\rho\gamma}\left(\theta K_F^\rho + (1-\theta)K_I^{\rho\gamma}N_I^{\rho(1-\gamma)}\right)^{\alpha-\rho/\rho}\right]\times$$

$$\left[1 + \frac{(1-\theta)(\alpha-\rho)K_I^{\rho\gamma}N_I^{\rho(1-\gamma)}}{\rho(\theta K_F^\rho + (1-\theta)K_I^{\rho\gamma}N_I^{\rho(1-\gamma)})}\right]. \tag{25}$$

For the private monopoly, in contrast, two first order conditions were obtained:

$$q = \left[A\alpha(1-\theta)\gamma\rho N_F^{1-\alpha}N_I^{(1-\gamma)\rho}K_I^{\rho\gamma-1}\left(\theta K_F^\rho + (1-\theta)K_I^{\rho\gamma}N_I^{\rho(1-\gamma)}\right)^{\alpha-\rho/\rho}\right]\times$$

$$\left[1 + \frac{(1-\theta)(\alpha-\rho)K_I^{\rho\gamma}N_I^{\rho(1-\gamma)}}{\rho(\theta K_F^\rho + (1-\theta)K_I^{\rho\gamma}N_I^{\rho(1-\gamma)})}\right] \tag{26}$$

$$w = \left[A\alpha(1-\theta)(1-\gamma)\rho N_F^{1-\alpha}N_I^{(1-\gamma)\rho-1}K_I^{\rho\gamma}\left(\theta K_F^\rho + (1-\theta)K_I^{\rho\gamma}N_I^{\rho(1-\gamma)}\right)^{\alpha-\rho/\rho}\right]\times$$

$$\left[1 + \frac{(1-\theta)(\alpha-\rho)K_I^{\rho\gamma}N_I^{\rho(1-\gamma)}}{\rho(\theta K_F^\rho + (1-\theta)K_I^{\rho\gamma}N_I^{\rho(1-\gamma)})}\right]. \tag{27}$$

Finally, for the perfectly competitive firms the corresponding maximizing conditions are

$$w = r(1-\gamma)K_I^\gamma N_I^{-\gamma} \tag{28}$$

$$q = r\gamma K_I^{\gamma - 1} N_I^{1-\gamma} . \qquad (29)$$

The respective profit maximizing conditions of the firms together with the consumer's utility maximizing condition, the balanced budget condition and the market clearing conditions, provide a system of equations that can be solved to find the steady state equilibrium of the economy for each regime. Those systems, however, cannot be solved analytically, and a numerical solution was necessary in order to be able to compare the different steady states. Thus, as in the previous section, parameter values need to be chosen in order to conduct the exercise.

We start by discussing the range of values chosen for ρ. The empirical estimates for this parameter, which governs the elasticity of substitution between capital and energy, go from –32 to12. Prywes (1986), for example, estimated the elasticity of substitution between aggregate capital and total energy use for several US industries and found values that ranged from 0.04 (ρ = -24) to -0.09 (ρ = 12). In Prywes (1986) estimations the value of ρ takes on values above unity for 6 out of 19 industries, a theoretical impossibility[25]. Others like Berndt and Wood (1975), and Magnus (1979), however, also obtained similar results.

In a more recent study, Kemfert (1998) conducted a study for Germany both at the aggregate level and at the industry level. For the aggregate level, Kemfert estimates the elasticity of substitution between capital and energy to be 0.65 (ρ = -0.5) while at the industry level the estimated values varied from 0.93 (ρ = -0.07) to 0.34 (ρ = -1.9) for most industries. Chang (1994), using a measure of energy that included coal, oil products, natural gas and electricity, obtained a similar estimate for the aggregate

Taiwanese economy. His estimated elasticity of substitution is 0.87; thus implying a value of $\rho = -0.14$. In contrast, authors like Burnside et al. (1995) have reported estimates of ρ that are below -2.3.

In this paper we use a set of values for the parameter ρ between 0.5 and -1. This range of values allows us to solve the model and observe how the results change as we move away from the Cobb-Douglas case. For each value of ρ, however, there is a value of θ associated with it that determines the income shares of both K and E as well as the ratio of total energy and total capital used. Here we have chosen to fit the value of θ such that the total income share of the intermediate good E in the perfect competition case is approximately equal to 4%.

The specific value of 4% is in line with the empirical evidence presented in the previous section about the income shares of such intermediate industries. Furthermore, when θ is chosen in such way, the resulting E/K ratio approaches 0.2 as ρ approaches zero; a result that is not at odds with the empirical evidence available for countries like the USA (see Kim and Loungani (1992) for references on the actual energy/capital ratio for the US during the period 1949-1987[26] and for a similar way to choose this parameter). Similar to the Cobb-Douglas case for the value of φ, however, a variation in the value of θ is not likely to alter our results. Furthermore, the values for the parameters A, α,τ, γ, δ, and β are identical to the ones used in the previous section.

[25] According to Prywes (1986), "most of these elasticity estimates are close to zero and the true statistics may be zero".
[26] Energy use is measured as total consumption of fossil fuels

Figures 7-9 use these parameter values and show the steady state income levels for the three regimes when the value of Ψ that equals 0.01, 0.025 and 0.05 respectively[27]. Two important results can be highlighted from these figures. First, in terms of income levels the benefits of competition relative to public monopoly become greater for smaller values of ρ. Second, as the parameter ρ becomes more negative, the difference between the income levels resulting from the private and the public monopoly cases becomes very small. Intuitively, as the intermediate good becomes more necessary for the production of final goods, the monopolist faces a more inelastic demand, and thus, their production choice becomes smaller relative to the competitive regime.

Thus, the model predicts that the impact of state-to-market transitions on the aggregate level of income depends crucially on whether markets are deregulated at the same time they are privatized. The size of this impact varies according to the degree to which capital and the intermediate good being deregulated act as complements or substitutes; that is, on whether the production technology depends importantly on the intermediate good or not.

5. Conclusions and Future Research

The last twenty years have seen a worldwide tendency toward the privatization and the deregulation of intermediate markets that were previously kept under government control. This transition has brought a heated debate and even national confrontations about costs and benefits of privatization/deregulation, especially in countries where, in the past, the government has played a large role in the provision of goods and services.

[27] For ease of presentation, the scale on the horizontal axes of Figures 7-9 was reversed.

The contribution to this debate made by cross-country econometric comparisons is limited because privatization and deregulation usually occur together within a short time period and because those studies are unable to account for some relevant country specific elements. Thus, at least some of the questions asked in this debate must be answered using a theoretical framework like the one presented here.

The results obtained in this paper suggest that the benefits of state-to-market transitions are mostly due to increased competition on the deregulated market, and that the privatization of state enterprises by itself is not likely to generate significant changes in the economy. In fact, the model predicts that for high enough levels of public investment, a public monopoly would be preferred to a private monopoly in terms of the resulting aggregate income level. Furthermore, the model points out that the gains from deregulation vary according to the production technology parameters chosen and thus, that they are also likely to vary from one country to another as the availability of natural and human resources vary.

In this paper, however, several important elements were not included. First, the presence or absence of a monopolistic market might generate different incentives for adopting new technologies. Second, the goals of a public enterprise might not be maximizing profits. Third, the presence of strong bureaucracies and unions might act against the productive efficiency of public firms. We believe that this and other issues could be studied in the future within a similar theoretical framework.

Table 1: Steady State Closed Form Solutions for the Cobb-Douglas Technology

Perfect Competition	Private Monopoly	Public Monopoly
$N_I = \dfrac{\varphi(1-\gamma)}{1-\alpha-\varphi\gamma}$	$N_I = \dfrac{\varphi^2(1-\gamma)}{1-\alpha-\varphi(1-\varphi+\varphi\gamma)}$	$N_I = \dfrac{\varphi^2(1-\gamma)}{1-\alpha-\varphi(1-\varphi+\varphi\gamma)}$
$N_F = \dfrac{(1-\alpha-\varphi)}{1-\alpha-\varphi\gamma}$	$N_F = \dfrac{(1-\alpha-\varphi)}{1-\alpha-\varphi(1-\varphi+\varphi\gamma)}$	$N_F = \dfrac{(1-\alpha-\varphi)}{1-\alpha-\varphi(1-\varphi+\varphi\gamma)}$
$K_I = \dfrac{K_1^{*}\varphi\gamma}{\varphi\gamma+\alpha}$	$K_I = \dfrac{K_2^{*}\varphi^2\gamma}{\varphi^2\gamma+\alpha}$	$K_I = \left(\dfrac{\psi c}{\delta}K_F^{*}\right)^{\frac{1}{1-\gamma\varphi}}$
$K_F = \dfrac{K_1^{*}\alpha}{\varphi\gamma+\alpha}$	$K_F = \dfrac{K_2^{*}\alpha}{\varphi^2\gamma+\alpha}$	$K_F = K_F^{*}$
$K_1^{*} = \left[\dfrac{\left(\frac{1}{\beta}-(1-\delta)\right)(1-\alpha-\gamma\varphi)^{1-\alpha-\gamma\varphi}(\gamma\varphi+\alpha)^{-1+\alpha+\gamma\varphi}}{A\alpha^{\alpha}(1-\tau)(\varphi(1-\gamma))^{(1-\gamma)\varphi}(1-\alpha-\varphi)^{1-\alpha-\varphi}(\gamma\varphi)^{\gamma\varphi}}\right]^{\frac{1}{-1+\alpha+\gamma\varphi}}$		
$K_2^{*} = \left[\dfrac{\left(\frac{1}{\beta}-(1-\delta)\right)(1-\alpha-\varphi(1-\varphi+\gamma\varphi))^{1-\alpha-\gamma\varphi}(\gamma\varphi^2+\alpha)^{-1+\alpha+\gamma\varphi}}{A\alpha^{\alpha}(1-\tau)(\varphi^2(1-\gamma))^{(1-\gamma)\varphi}(1-\alpha-\varphi)^{1-\alpha-\varphi}(\gamma\varphi^2)^{\gamma\varphi}}\right]^{\frac{1}{-1+\alpha+\gamma\varphi}}$		
$K_F^{*} = \left[\dfrac{\left(\frac{1}{\beta}-(1-\delta)\right)\delta^{\frac{\gamma\varphi}{1-\gamma\varphi}}}{A\alpha(\psi c)^{\frac{\gamma\varphi}{1-\gamma\varphi}}\left(\frac{\varphi^2(1-\gamma)}{1-\alpha-\varphi(1-\varphi+\varphi\gamma)}\right)^{(1-\gamma)\varphi}\left(\frac{(1-\alpha-\varphi)}{1-\alpha-\varphi(1-\varphi+\varphi\gamma)}\right)^{1-\alpha-\varphi}}\right]^{\frac{1}{-1+\alpha+\gamma\varphi}}$		
$c = A\varphi N_F^{1-\alpha-\varphi}N_I^{(1-\gamma)\varphi} - A\varphi N_F^{1-\alpha-\varphi}N_I^{(1-\gamma)\varphi-1}(1-\gamma)\varphi + AN_F^{-\alpha-\varphi}N_I^{(1-\gamma)\varphi}\tau(1-\alpha-\varphi) + A\tau\alpha N_I^{(1-\gamma)\varphi}N_F^{1-\alpha-\varphi}$		

Table 2: Parameter Values

Parameter	Value
A	1
α	0.36
δ	0.1
τ	0.2
β	0.95
γ	0.4
φ	0.05, 0.1, 0.2, 0.3

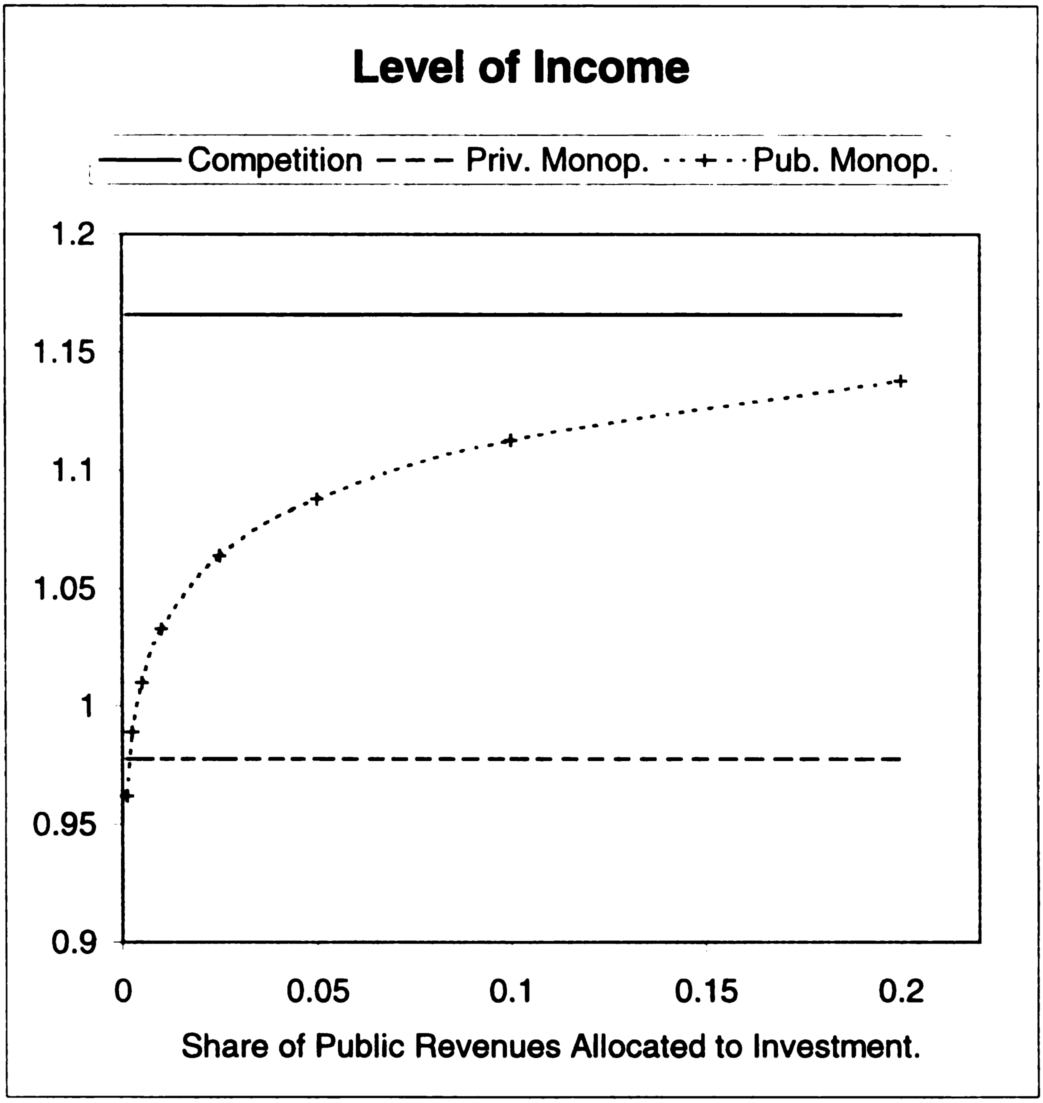

Figure 1: Steady State Level of Income for Different Intermediate Market Structures and Different Levels of Public Investment. (φ =0.04)

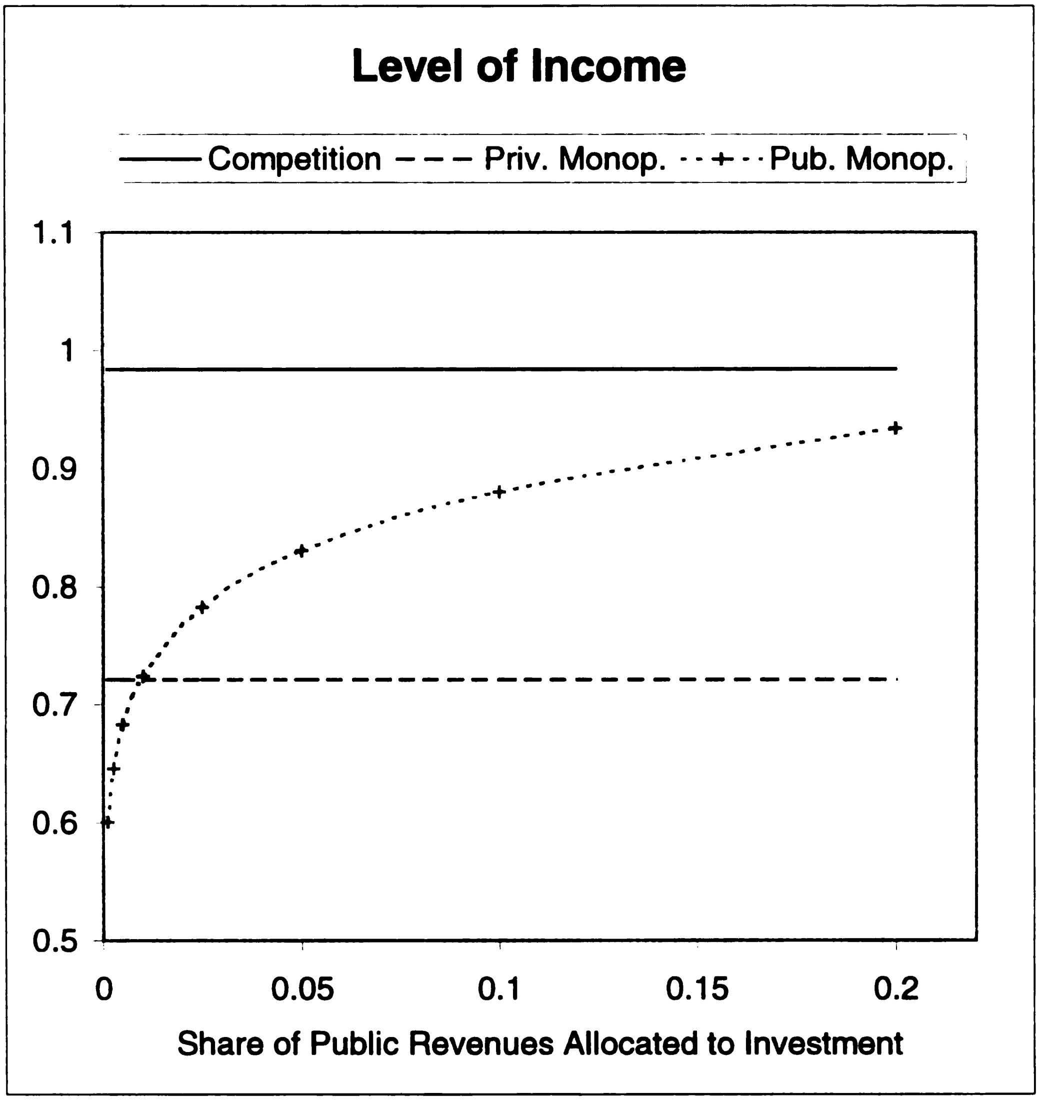

Figure 2: Steady State Level of Income for Different Intermediate Market Structures and Different Levels of Public Investment (φ =0.1)

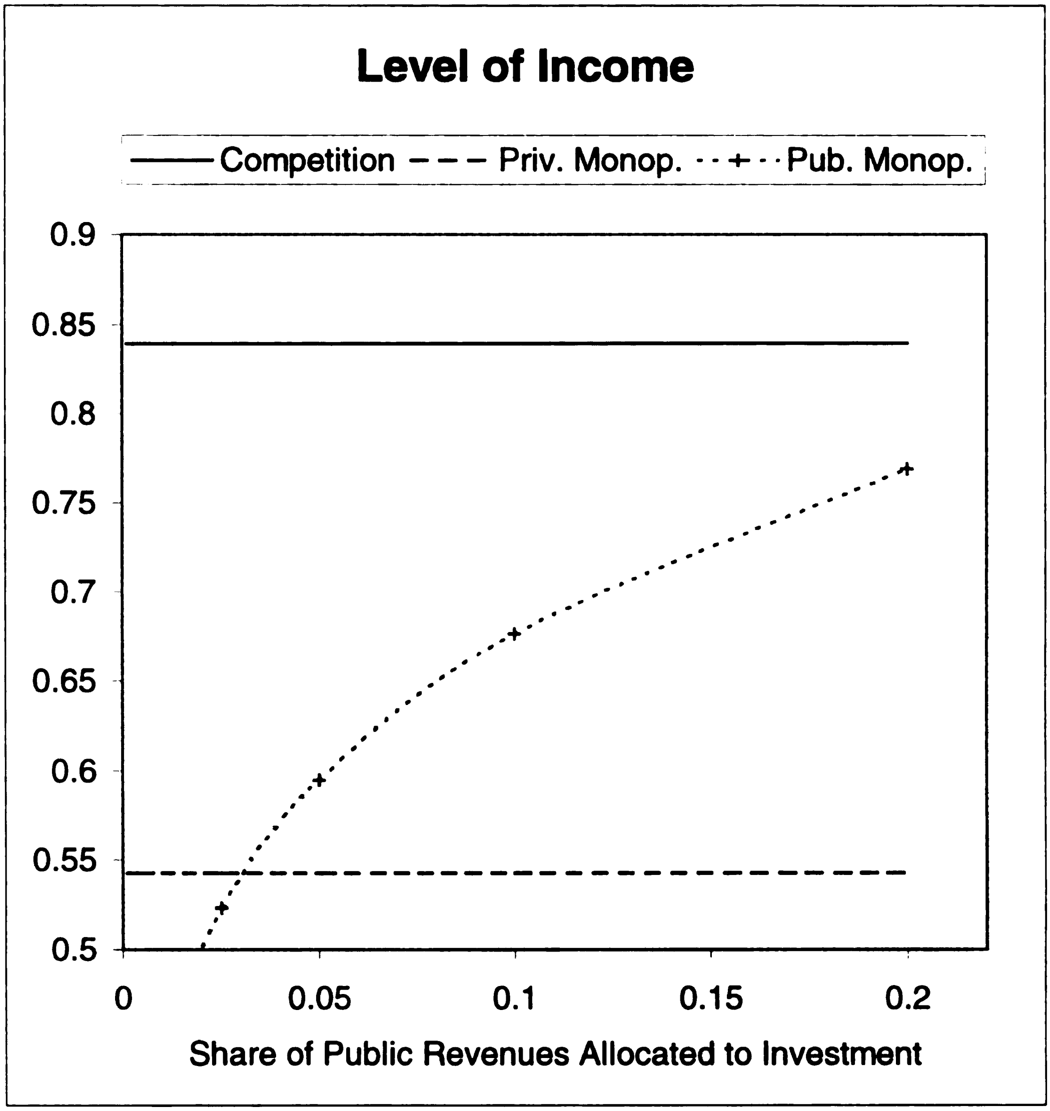

Figure 3: Steady State Level of Income for Different Intermediate Market Structures and Different Levels of Public Investment (φ =0.2)

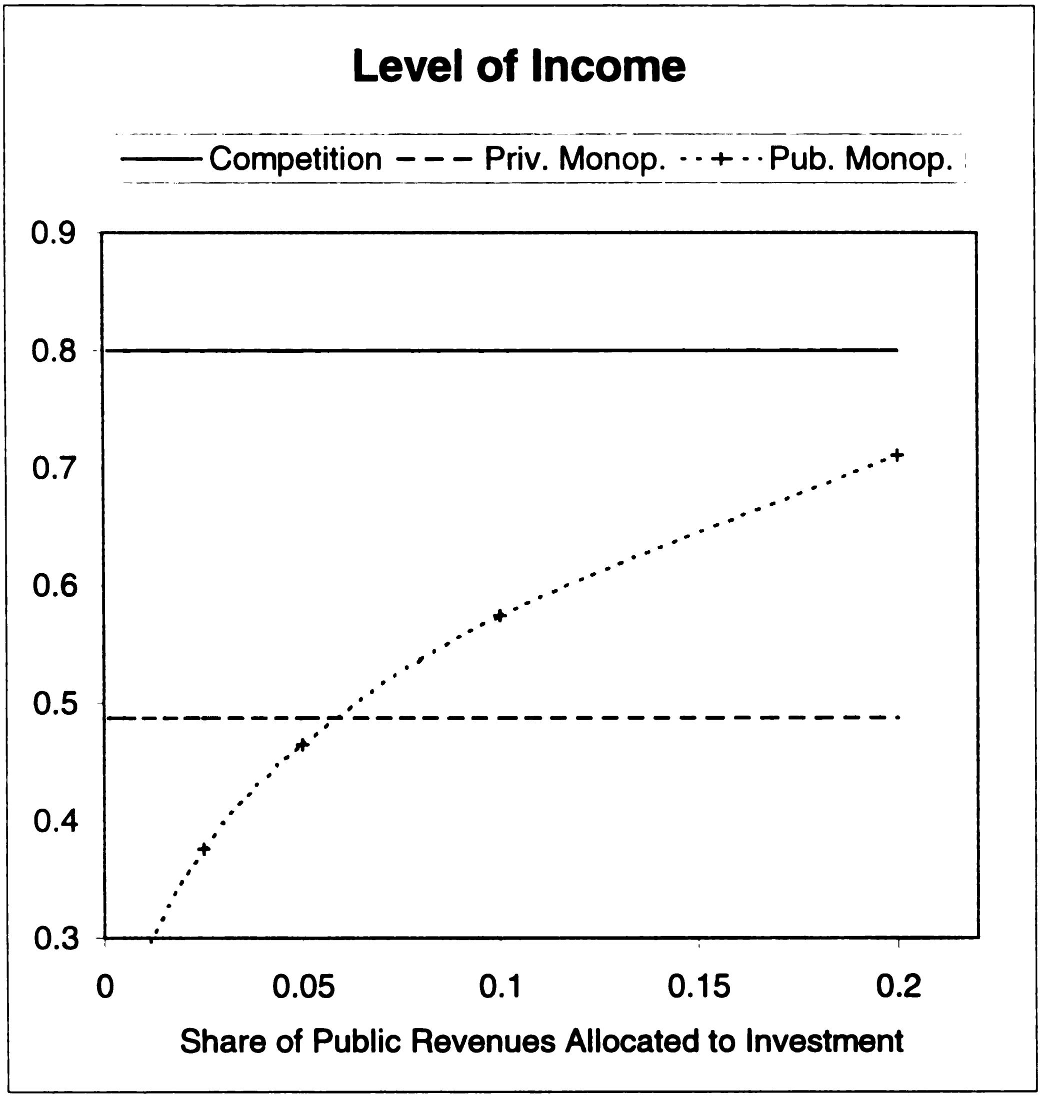

Figure 4: Steady State Level of Income for Different Intermediate Market Structures and Different Levels of Public Investment (φ =0.3)

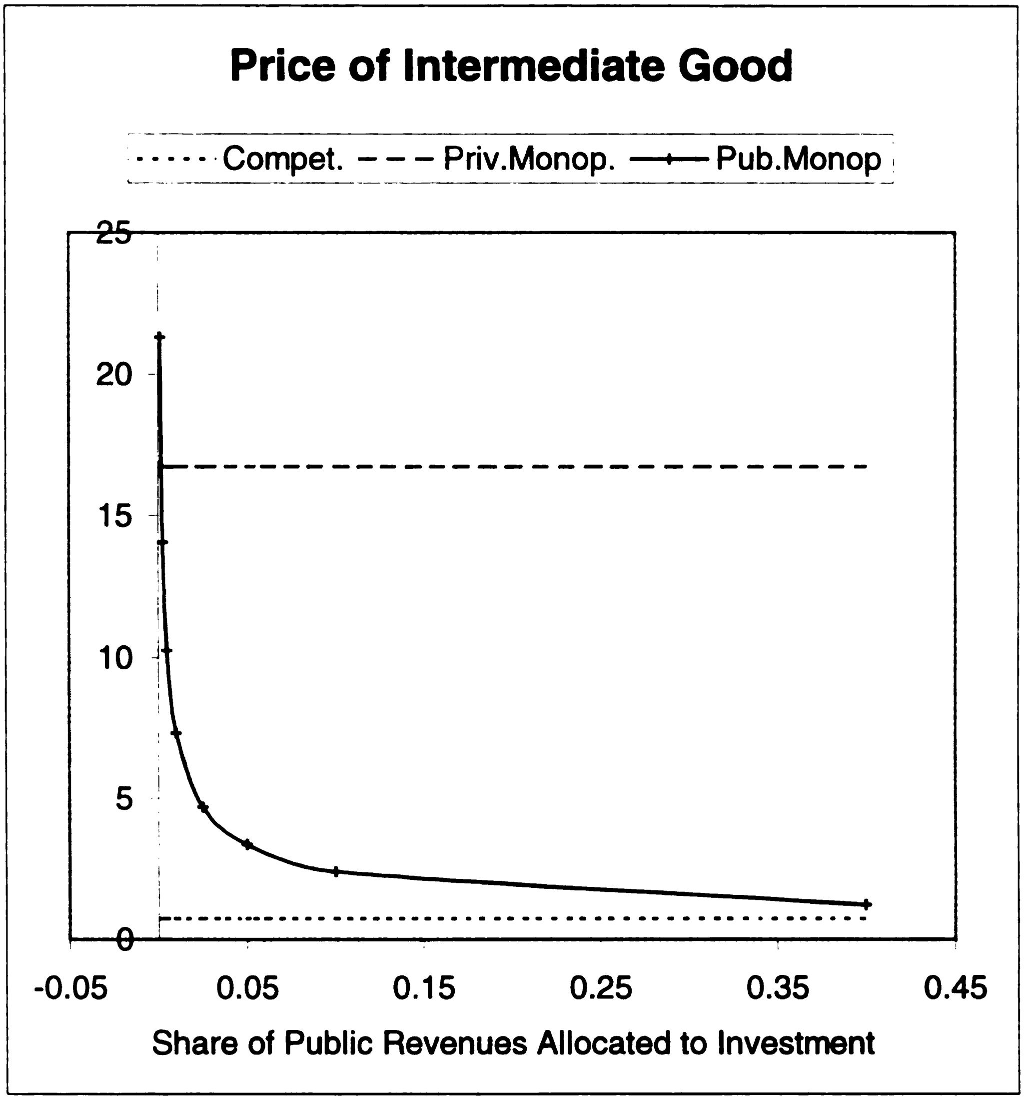

Figure 5: Steady State Price of the Intermediate Good for Different Intermediate Market Structures and Different Levels of Public Investment (φ =0.04)

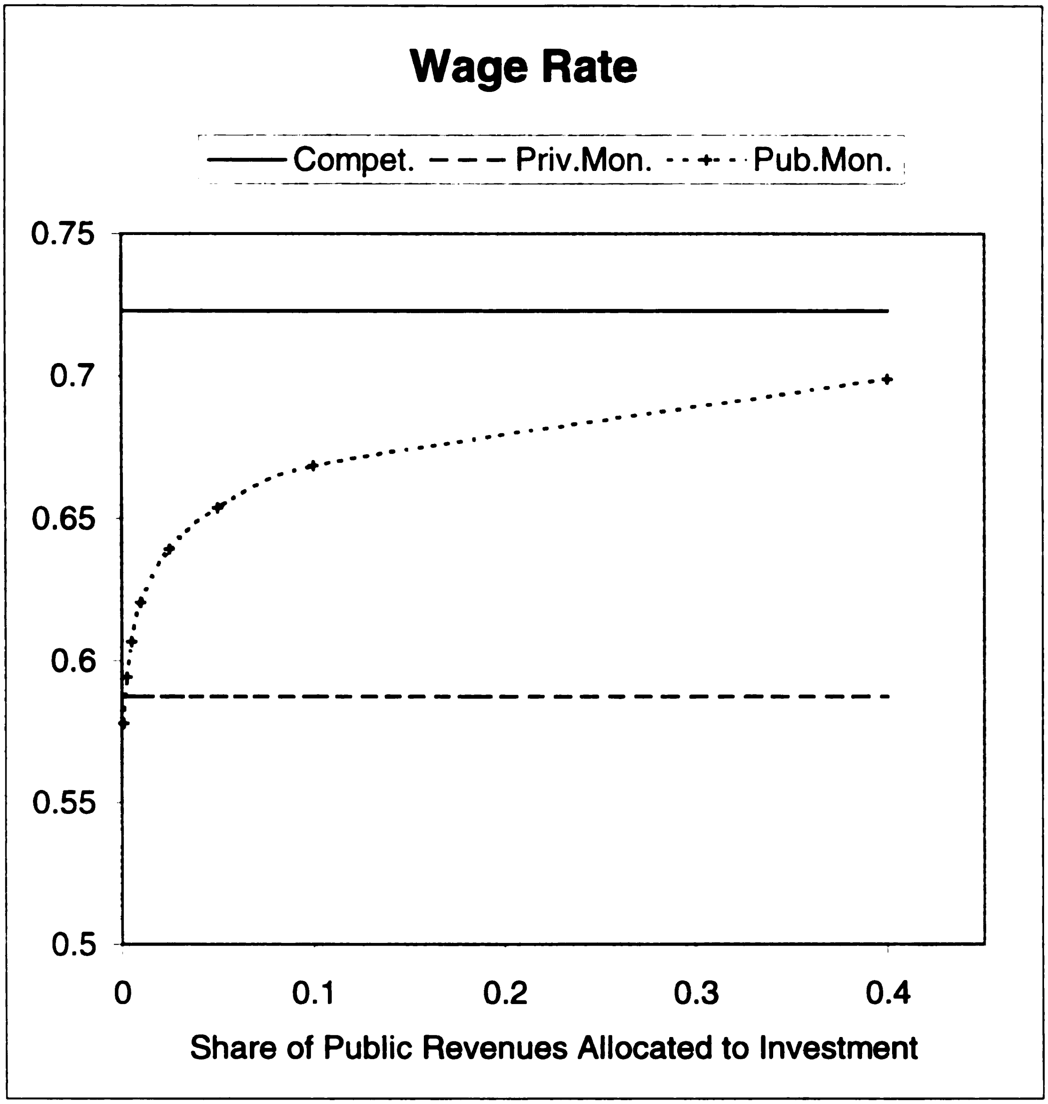

Figure 6: Steady State Wage Rates for Different Intermediate Market Structures and Different Levels of Public Investment (φ =0.04)

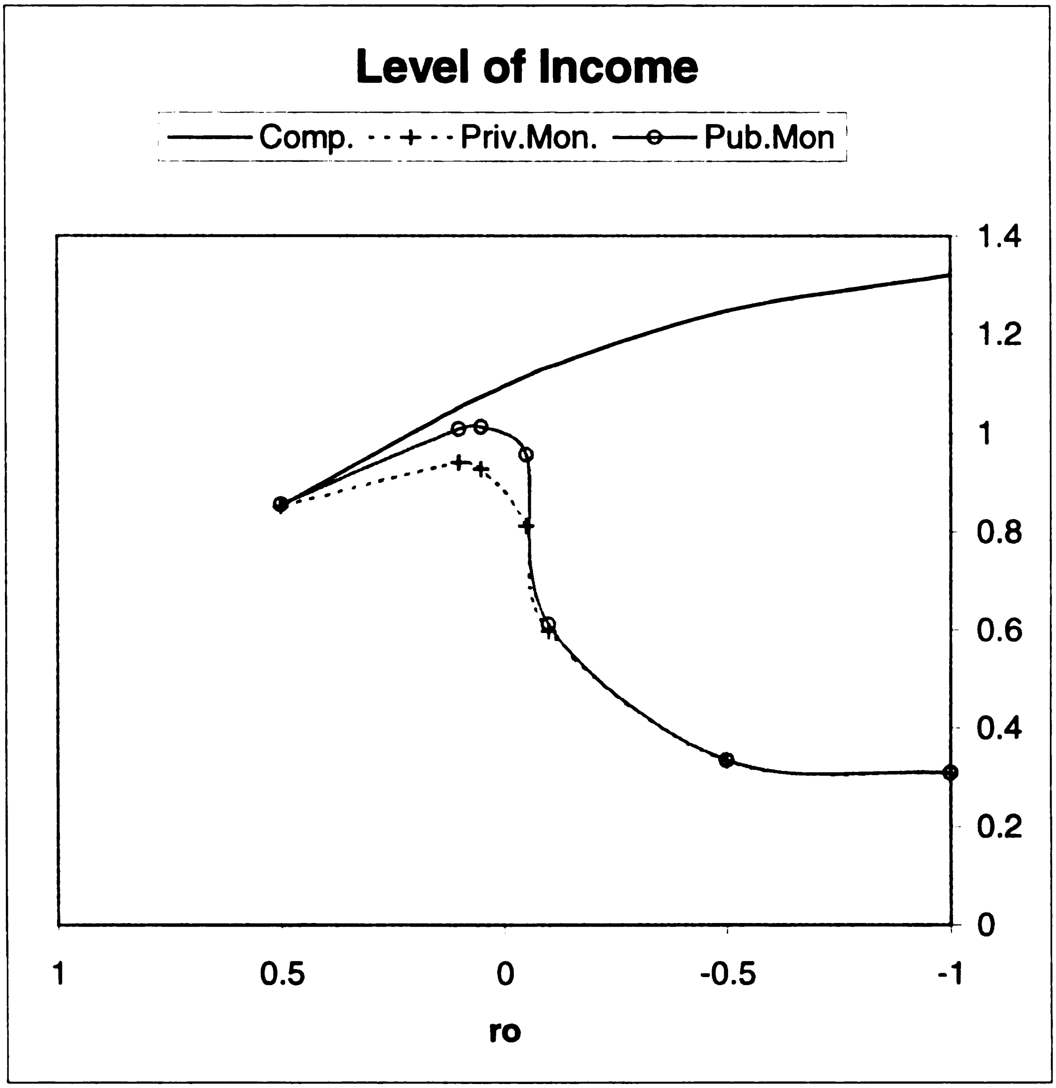

Figure 7: Steady State Levels of Income for Different Values of ρ When ψ = 0.05

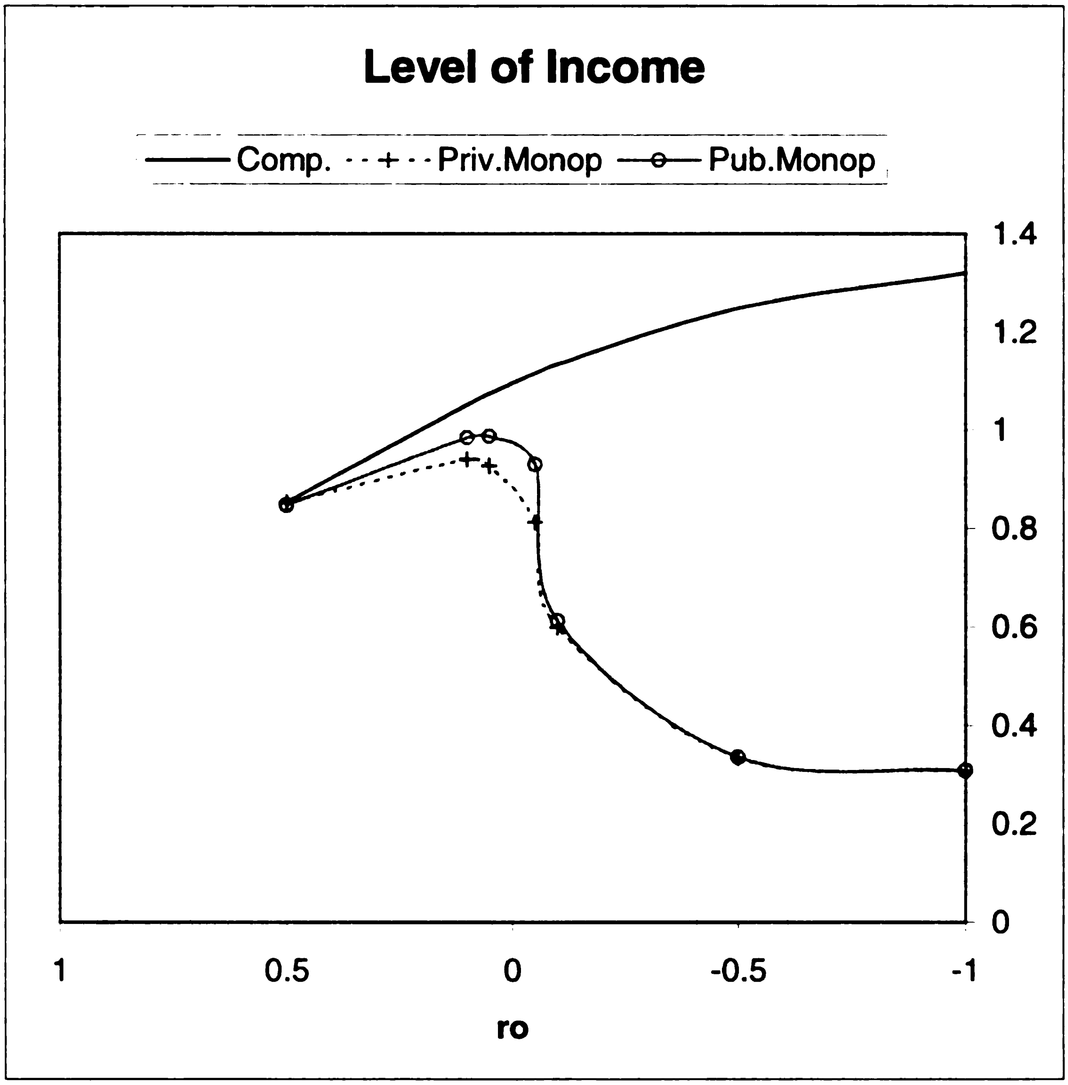

Figure 8: Steady State Levels of Income for Different Values of ρ When $\psi = 0.025$

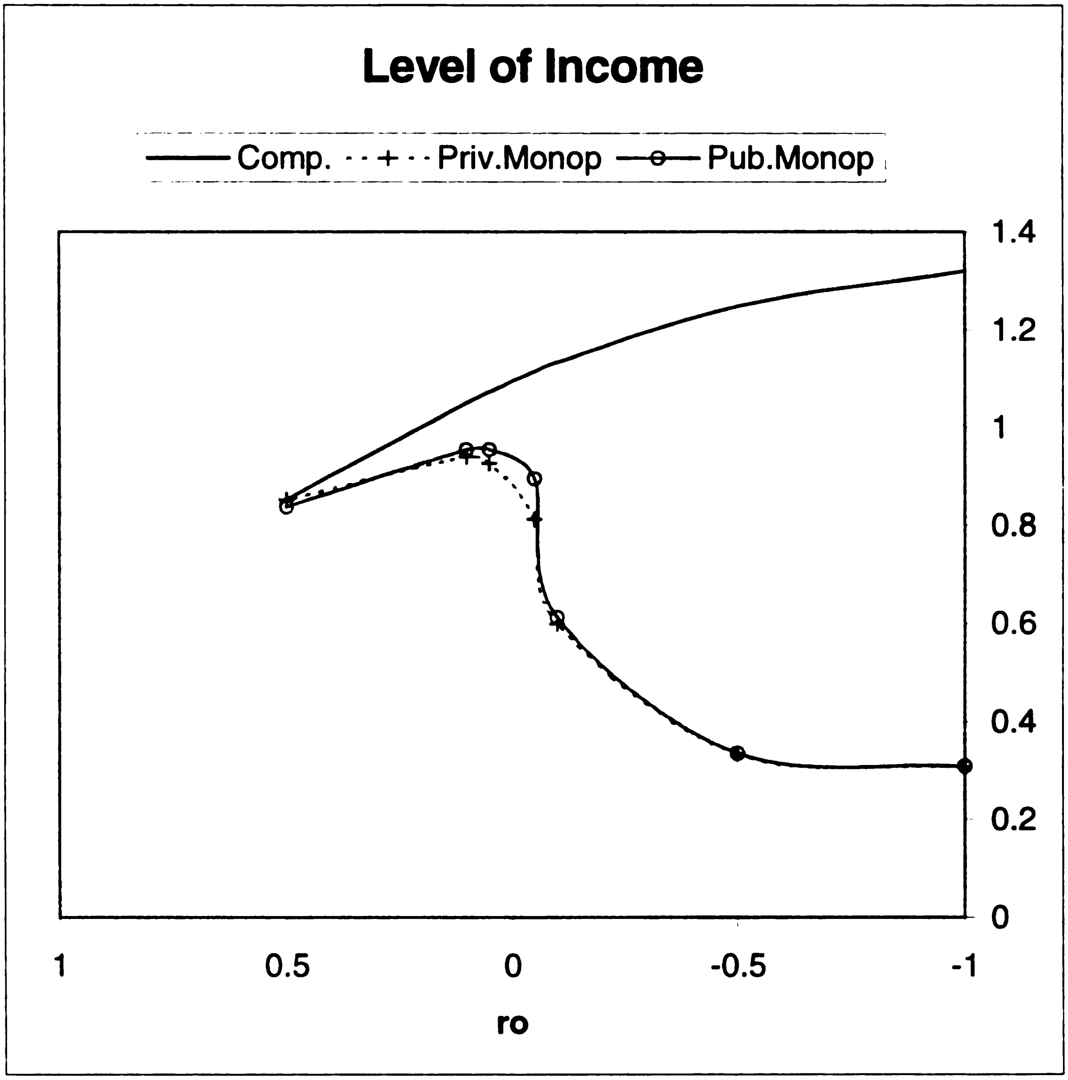

Figure 9: Steady State Levels of Income for Different Values of ρ When ψ = 0.01

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