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ABSTRACT

A Neoclassical Growth Model for the Insiders – Outsiders Society

The wage premium in the public sector, as measured by the ratio of the average wage rate in the public sector relative to the average wage rate in the private sector, varies considerably across developed economies. And, varies in some developed economies over large periods of time. Further, this wage premium in the public sector correlates negatively with the conditional growth rate, in a representative panel of developed economies. This paper develops a simple neoclassical growth model, motivated by the paradigm of the South European countries that top the list of developed economies with the highest wage premium in the public sector, to provide for a unifying explanation for these stylized facts. According to this model, the latter are consequences of the different organization of the labor market and an associated political system complementarity. Labor supply consists of two groups: “outsiders”, that are employed by the private sector (final good) and take the wage rate as given, and “insiders” that are employed by the public sector (services associated with intermediate goods, such as basic networks and utilities) and are members of unions that set the wage rate. In this case, there will be a wage premium in the public sector and an associated labor misallocation effect. The number of intermediate goods raises the wage premium due to the assumed gross complementarity in the production of the final good. Thus, unions have an incentive to cooperate, so as to control/influence government and, thereby, the maintenance of existing and the creation of new intermediate goods. This is the above mentioned political system complementarity. Whether, steady state output and growth towards the steady state rise or fall with an increase in the number of intermediate goods, depends on the existing number of these goods. If this number is relatively low (high), the “variety” effect dominates over (is dominated by) the combination of the labor misallocation and distorting taxation effects. The latter stems from distortionary income taxation, needed to finance the infrastructure of the publicly provided intermediate goods. Then, it is shown that, for plausible parameter values, in the steady state, a “government of insiders”, that seeks to maximize the aggregate of insiders’ unions utilities, will tend to have a higher number of publicly provided intermediate goods than the number that would have been chosen by the Median Voter. These results form the basis for explaining the above mentioned stylized facts, as well as important aspects of the present crisis of the South European economies.

JEL Classification: J31, J45, O43, O52 and P16
Keywords: growth, insiders-outsiders, political institutions, public sector wage premium and varieties of capitalism

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1. INTRODUCTION

As there is no obvious economic reason why the average wage rate in the public sector relative to the average wage rate in the private sector (the "public sector wage premium"), should be very different from country to country, or why it should vary considerably across time in the same country, the bars of Figure 1, below, should come as a big surprise.[1] First, as the bars representing averages indicate, public sector wage premia are quite different across a representative sample of developed economies. Second, as the comparison between the bars representing the maximum and the minimum for the same country indicates, in some of those economies, the public sector wage premium exhibits significant variability over time.[2] Moreover, as the scatter plot of the average public sector wage premium and the respective average ratio of public over total employees, in Figure 2, indicates, there is a strong and statistically significant negative correlation between them. Furthermore, Figure 3 shows the conditional correlation between the growth rate and the public sector wage premium. In particular, the vertical axis measures the five year average growth rates, after they have been filtered for the estimated effects of the explanatory variables thought to be important determinants of growth.[3] The horizontal axis shows the five year average wage premium. As can be seen, there is a negative and statistically significant relationship between this growth rate and the public sector wage premium. This result might have ominous implications for the countries with relatively high wage premia in the public sector, like the four South European countries, that top the list, in Figure 1.

In general, these stylized facts raise some obvious questions for both theory and policy. Why do they exist, in the first place?[4] And, most importantly, what are their implications for the behavior of the aggregate level of economic activity, public finances and other key macro variables?

[1] There is, of course, a voluminous literature in labor economics that explores the reasons for the existence and properties of wage premia across industrial sectors of the same country (see, e.g., Dickens and Katz (1987), Katz and Summers (1989), Gibbons and Katz (1992), Gibbons et al. (2005), Caju et al. (2011)). Occasionally, there have been papers that study the existence and properties of the wage premium in the public sector in individual countries (see, e.g., for Greece: Christopoulou and Monastiriotis (2013); for Portugal: Campos and Pereira (2009); for Spain: Garcia-Perez and Jimeno (2007); for Italy: Depalo and Giordano (2011); and for Australia: Cai and Liu (2011)). Recently, there have been studies that show empirically that Greece, Portugal, Spain, Italy, and Ireland exhibit higher public sector wage premia than other Euro Area countries (Giordano et al. (2011) and Campos and Centeno (2012)). Bender (1998) provides a review of the empirical literature, that examines public-private sector wage differentials. Afonso and Gomes (2008), Fernado de Cordoba et al. (2012) and Lamo et al. (2013), examine the interactions between private and public sector wages both theoretically and empirically. None of these papers, however, relate the wage premium in the public sector to other macro variables (stylized facts) and, most importantly, they do not relate public sector wage premia differentials to growth differentials across countries, or for a given country, to growth differentials over time.

[2] The years that correspond to the minimum and maximum of the wage premium in the public sector in the countries with the highest average wage premium in the public sector in Figure 1 are as follows: Greece (1978, 2009), Portugal (1983, 1991), Spain (1997, 1970) Australia (2007, 1983), Italy (1976, 2009) and Ireland (1978, 2007).

[3] The unexplained part of the growth rates refer to the residuals obtained from the standard Barro regressions. Formally, these residuals are computed by running a regression that includes all the explanatory variables, other than the public sector wage premium (see Table 2, in the Appendix). Similar results can be obtained with different sets of explanatory variables.

[4] Kollintzas et al. (2013), confirming the bulk of studies mentioned in Footnote 1, provide evidence that only a small percentage of public sector wage premia in countries with a relatively high public sector wage premium, like the

Figure 1: Average compensation rate in the public sector relative to the private sector

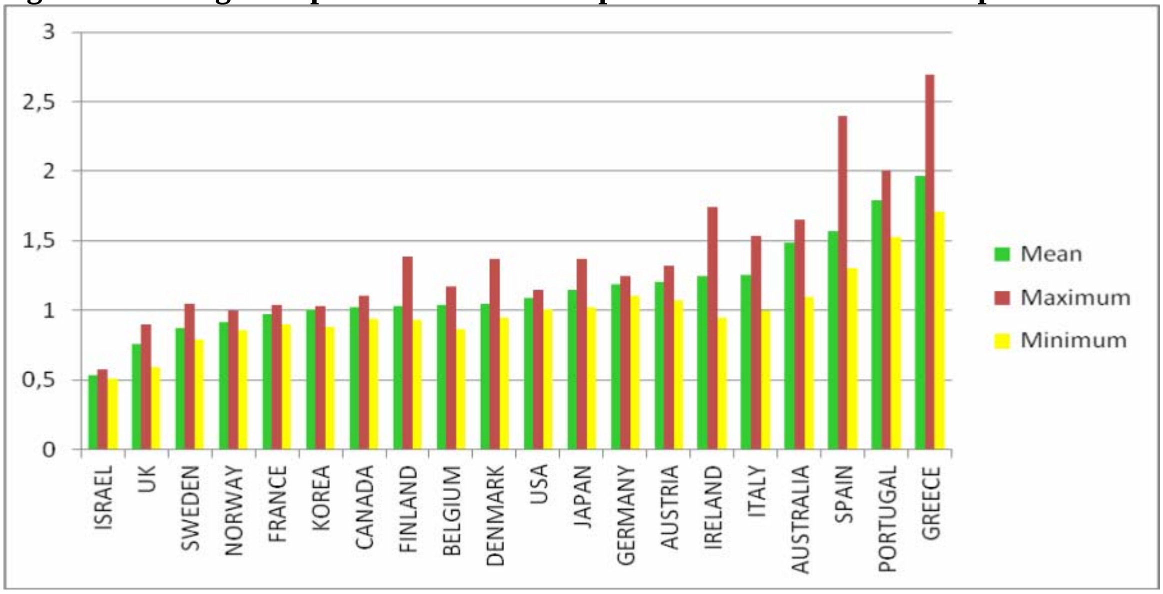


Figure 2: Public sector wage premium versus the ratio of public sector employees over total employees

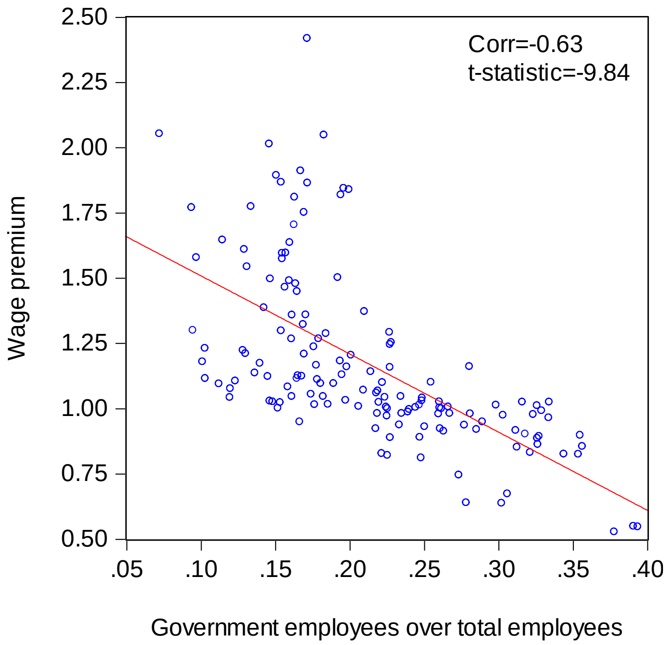
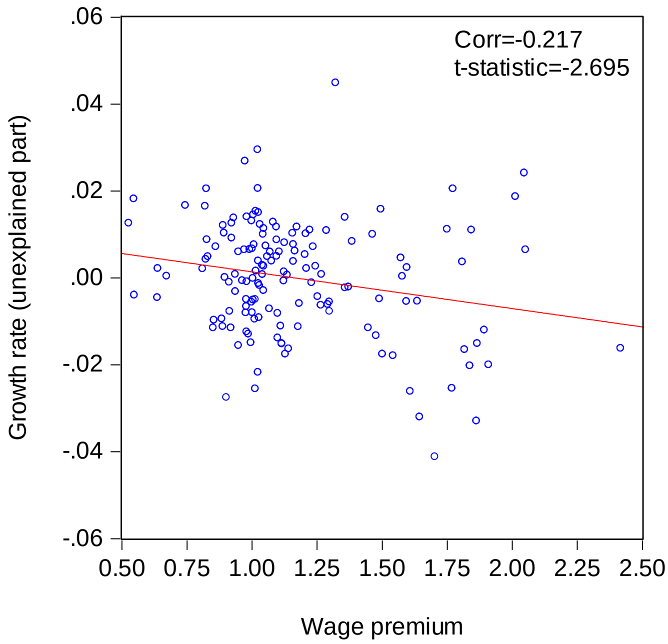


Figure 3: Growth rate versus the public sector wage premium



Notes on Figure 1: (i) The average compensation rate in the private sector is computed as the ratio between the total compensation of employees in the private sector and private sector employees (ii) The average compensation rate in the public sector is computed as the ratio between general government final wage consumption expenditure and general government employment, (iii) Data for the wage premium cover the period 1970-2010, with the exception of Denmark (1971-2010), Germany (1991-2010), Ireland (1971-2010), Israel (1999-2010), Korea (1975-2010) and Portugal (1977-2010).
Note on Figures 2, 3: Data definitions and methodology in the Appendix.

This paper seeks to explain the above mentioned stylized facts, motivated by the organization of the economic and political systems of the South European countries. These countries have relatively large public sectors, with basic networks and utility services provided by government and

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Southern European countries, can be explained by the usual variables thought to be important determinants of wage differentials, like education, tenure, sex, etc.

more importantly by agencies or firms that, on the one hand, are heavily regulated and, on the other hand, labor therein is organized in powerful labor unions. Moreover, there are important strategic interactions between these unions and the government.[5] Thus, this paper develops a simple neoclassical growth model, motivated by the experience of South European countries, that provides for a unifying explanation of these stylized facts. According to this model, these stylized facts are consequences of the different organizational structure of the labor market across countries or for the same country over time, that has important implications for the workings of the respective economic and political systems.

In particular, this model incorporates and extends the idea of the insiders – outsiders labor market of Lindbeck and Snower (1986), with wages differing across identical labor services due to the particular organization of the labor market.[6] Although insiders and outsiders are identical, the wages of insiders are higher than those of the outsiders, creating a misallocation effect that lowers output and output growth towards the steady state. More specifically, outsiders work on the production of a final good, while insiders work on the production of intermediate goods, produced by monopolies controlled by Government. For that reason, intermediate goods enter the final goods production function through a Dixit-Stiglitz aggregator, that incorporates the so called "variety" effect, whereby an increase in the number of intermediate goods increases output. Further, this aggregator allows for intermediate goods to be gross complements, as one should think of the services of various networks, provided by the State (e.g., power, water, phone, roads, railways, harbors, airports, etc.). The wage rate of outsiders is determined competitively. Each intermediate good producer prices its output satisfying a zero profit condition, taking the wage rate offered by the corresponding insiders' union as given. This determines each intermediate good producer's employment and output. Then, the corresponding wage rate is determined by the respective union, that takes the demand for labor it faces, as given. This is the well known Monopoly-Union model of McDonald and Solow (1981) and Oswald (1983). Since there are as many unions of insiders as there are intermediate good producers, overall equilibrium in the market for insiders' labor is characterized by a Nash equilibrium among all insiders' unions. In the symmetric equilibrium case,

[5] This interaction has been recognized in the political science literature since the late seventies (Schmitter (1977), Sargent (1985), Cawson (1986)).

[6] In the insiders-outsiders theory of Lindbeck and Snower (1986), some worker participants ("insiders") have privileged positions relative to others ("outsiders"). Insiders get market power by resisting competition in a variety of ways, including harassing firms and outsiders that try to hire / be hired, by underbidding the wages of insiders and by influencing pertinent legislation (Saint-Paul (1996)). The insiders-outsiders labor market idea was extended to the society as a whole in Kollintzas et al. (2012), to explain the current Greek crisis. There has been an extensive empirical literature on the existence and properties of insiders-outsiders labor markets (see e.g. Holmlund and Zetterberg (1991), Bentolila and Dolado (1994), Bentolila et al. (2012)). The last two papers, most significantly, refer to Spain. There has been no association of the wage premium in the public sector and insiders-outsiders labor market, to our knowledge, in the literature. However, the importance of insiders-outsiders labor markets for providing the microeconomic foundations for justifying the strength of unions has been at the core of this literature (see, e.g., the surveys by Lindbeck and Snower (2001, 2002). As already mentioned, in the previous footnote, the strength of the unions in the public sector in the South European countries has been noticed in the political science literature.

given reasonable parameter restrictions, the ratio of the wage rate of insiders over that of the outsiders (i.e., the wage premium in the public sector) is greater than one and increasing in the degree intermediate goods are gross complements, as well as in the number of publicly provided intermediate goods. Moreover, the wage premium and the ratio of employment in the public sector over total employment are inversely related, giving rise to the "labor misallocation effect". For a fixed number of insiders' unions, this model is formally equivalent to a standard Cass-Koopmans neoclassical growth model, where TFP declines with the wage premium, but increases with the number of intermediate goods, as the "variety" effect dominates over the "labor misallocation" effect. However, the overall effects on steady state capital, output and growth towards the steady state, depend on the after tax labor productivity. For it is assumed that the underlying infrastructure, associated with the publicly provided intermediate goods, is financed by a distortionary income tax. Then, it is shown that the effect of an increase in the number of publicly provided intermediate goods on steady state output and growth towards this steady state is negative (positive), depending on the existing number of publicly provided intermediate goods. If this number is sufficiently high (low), the combination of the "labor misallocation" and the tax distortion effects dominates over (is dominated by) the "variety" effect. All this being quite plausible, as the "variety" effect ("labor misallocation" and tax distortion effects) decreases (both increase) with the existing number of publicly provided intermediate goods.

Further, if the number of publicly provided intermediate goods is allowed to vary, each insiders' union realizes that it has a common interest with all other insiders' unions in controlling/influencing the number of publicly provided intermediate goods. Hence, it is to the interest of all insiders' unions to control/influence government and its budget. Thus, assuming that the political system allows the formation of a "government of insiders", seeking to maximize the aggregate of all the labor union utility functions, subject to the economic equilibrium and the government budget constraint, such a government, under plausible restrictions, would choose a number of publicly provided intermediate goods that would be greater than the number that a Median Voter social planner would have chosen. This, in turn, implies that the "government of insiders" will choose a higher (distortionary) income tax rate and/or debt level. This is the "political effect" that, depending on the number of publicly provided intermediate goods, may further reduce steady state capital, output, and output growth towards the steady state. It follows, therefore, that, to the degree that the political and economic system of a country is like the "insiders-outsiders" society of this theory, it would exhibit a relatively high wage premium in the public sector, low public to total employment ratio, and would exhibit labor misallocation and tax distortion effects that reduce steady state capital, output and growth towards this steady state.[7]

The results of this paper relate to several different strands of the literature on political economy, public finance, growth and European integration. First, it relates to the rent seeking / special interests political economy literature. In particular, it is based on two basic ideas of that literature. First, that insiders seek rents from the political system for their own benefit and that the agents of the political system accommodate these demands in pursuit of their economic and political goals. Second, that, once the political system allows it, rent seekers are formed in groups, so as to take advantage of their common interests in rent seeking, by controlling/influencing government.[8] Also, it shares with the recent political economy and economic growth literature, the idea that resources devoted to rent seeking are ultimately detrimental to growth.[9]

In his unifying theory Acemoglu (2006) develops a general framework for analyzing the growth implications of politico-economic equilibria, when there are three groups of agents: workers, "elite" producers and "middle class" producers. Elite producers control the government and tax middle class producers through a distorting income tax and distribute the proceeds among themselves via a lump-sum transfer. The motives for increasing the distorting tax are three: (a) "Revenue extraction": the provision of resources for the benefit of the elite; (b) "Factor price manipulation": the lowering of factor prices used in the elite's production process; and (c) "Political consolidation": the impoverishment of middle class producers, so as to prevent them from acquiring the resources necessary to achieve political power. To anticipate the workings of the model presented herebelow, we may think of insiders as acting according to Acemoglu's three motives. The first and the third of these motives for increasing the distorting income tax, are captured by the need for the maintenance of the existing (old) and the creation of the new publicly provided infrastructure that ensures the funding for their employers businesses. The second motive is captured by the fact that an increase in the income tax rate, although it lowers the after tax user cost of capital and the after tax wage rate of outsiders' labor, increases the user cost of capital and the wage rate of outsiders, lowering the demand for these factors and increasing the demand for services of intermediate good products. This, in turn, increases the demand for insiders' labor, in such a way so as to increase the wage premium in the public sector. Like in Acemoglu, it is this

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[7] Fernandez-de-Cordoba et al. (2012), consider a dynamic general equilibrium model that, as in our case, emphasizes the role of political economy issues in public-private wage developments. However, they focus in the behavior of public and private sector wages over the business cycle within the context of a non-cooperative game between unions and the government for the public wage determination.

[8] The idea that the various beneficiaries of government policies are more likely to get politically organized, whereas the interests of the un-organized general public are neglected is found in the pioneering works of Schattschneider (1935), Tullock (1959, 1967, 2010), Olson (1965), Weingast, Shepsle and Johansen (1981) and Becker (1983, 1985). See the authoritative surveys of Persson and Tabellini (2000, Ch. 7), Drazen (2000) and Grossman and Helpman (2002).

[9] See Parente and Prescott (1994), Krusell and Rios Rull (1996), Aghion and Howitt (1998), Angeletos and Kollintzas (2000), Hillman and Ursprung (2000), Acemoglu and Robinson (2008) and Acemoglu (2006, 2009 Chapters 22, 23).

effect that seems to be the most damaging for the economy. However, there are important differences between Acemoglu's framework and the one developed herein. First, the roles of "elite entrepreneurs" and "middle class entrepreneurs" are taken, here, by "insiders" and "outsiders", that they are both workers. Second, since insiders are organized in unions, that set the wage rate, there is an additional distortion in our model's economy over and above the tax distortion. This additional distortion strengthens Acemoglu's "factor price manipulation" effect. Third, there is a fundamental nonlinearity, as an increase in the distorting tax rate, so as to increase the number of publicly provided intermediate goods, may be beneficial for the economy, if the number of existing publicly provided intermediate goods is relatively low and the opposite may be true, if the existing number of those goods is relatively high.

Further, this paper relates to the "common pool" property of public finances whereby there is an inherent bias towards higher government spending (lower tax revenues), due to the externality present in the financing of specific government goods and services (tax cuts).[10] This externality is generated by the fact that those that enjoy the benefits of specific government benefits (tax cuts) are fewer and possibly different than those that pay for these benefits (share the cost of no tax cuts, such as with debt financing). And, as a result, there is higher demand for spending (tax cuts). In a way, the insiders-outsiders society incorporates the common pool problem, as the reason that an outsider does not react to the insiders behavior, is also due to the free rider apathy of those that share the cost of insiders' benefits. But, the insiders–outsiders society explanation goes beyond the existence of chronic public deficits due to political economy reasons, in connecting those deficits to lower capital, output, and output growth.

Furthermore, it relates to the "varieties of capitalism" literature of political science, pioneered by Hall and Soskice (2001), as well as Esping-Andersen's (1990) "three worlds of welfare capitalism" social model analysis. In this literature, it has been suggested (Molina and Rhodes (2007)) that the Southern European countries have their own "variety" of capitalism, where the state plays a major role. In a sense, the insiders-outsiders society idea is based on the institutional complementarity between market organizations, where the wage premium favors individual groups of society ("insiders") and the political system, where these groups control or influence government, for insiders' collective benefit. As already noted, this interaction has been emphasized on another strand of the political science literature, namely, that on "neo-corporatism" (Schmitter (1977), Sargent (1985), Cawson (1986)).[11]

[10] See Hallerberg and von Hagen (1999), Hallerberg et al. (2009), von Hagen and Harden (1994), Milesi-Ferretti (2004), Velasco (1999), Kontopoulos and Perotti (1999) and Eichengreen et al. (2011).
[11] See, also, Featherstone (2008).

Finally, our results should be of interest to the European integration question, as countries that have gone beyond a certain point toward the insiders-outsiders society (e.g., South European countries) will have a difficulty following the others in after tax TFP growth, as already suggested by several policy influential economists (see, e.g., Sapir (2006)).

The rest of the paper is organized as follows: Section 2 develops the model. Section 3 establishes the main results of the paper, under three alternative regimes: First, focusing on a specification where the number of intermediate public goods is fixed but capital per efficient labor unit follows a general Cass-Koopmans type law of motion. Second, focusing on a specification where the number of insiders unions is determined by the government budget constraint, but capital per efficient labor unit follows a Solow-type law of motion. Third, focusing on a specification where the number of insiders unions is determined by the "government of insiders" (i.e., a government that seeks to maximize the aggregate utility function of all unions of insiders, subject to the equilibrium laws of motion and the government budget constraint). In this case, the law of motion of capital per efficient labor unit is also of the Solow-type. Section 4 concludes with the model's explanation of the stylized facts considered earlier and a discussion of possible extensions of the paper.

2. THE MODEL

The model developed in this section is a neoclassical growth model of a closed economy that produces a homogeneous final good, which can either be consumed or saved and invested, by means of physical capital and labor services, as well as, the services of a number of intermediate goods provided by the state.

2.1 Households

This economy consists of a large number of identical households. Household preferences are characterized by a standard time separable lifetime utility function of the form $\sum_{t=0}^{\infty}\beta^t u(c_t)$; where: $\beta\in(0,1)$ is the household discount factor, c_t is consumption per capita in period *t*, and $u(c)=\dfrac{c^{1-\gamma}-1}{1-\gamma}, \gamma\in(0,\infty)$, is a temporal utility function, with constant elasticity of intertemporal substitution, $1/\gamma$. Households own the physical capital, that depreciates according to a fixed geometric depreciation rate, $\delta\in(0,1)$, so that capital stock evolves according to: $k_{t+1}=(1-\delta)k_t+i_t$, where k_t is capital stock at the beginning of period *t* and i_t is gross investment in period *t*. In every period t, each household has available a fixed amount of labor time, $\bar{h} \in (0,+\infty)$, that can be allocated to the production of the final good, h_t^o, and the production of services from a continuum of intermediate goods, $[0, N_t]$, provided by government. Thus, the time constraint of each household, in every period t, is given by:

$$h_t^o + \int_0^{N_t} h_t^i(z)\,dz \le \bar{h} \tag{1}$$

where: $h_t^i(z)$ is labor time devoted by each household to the production of services from the z intermediate good, in period t. And, the budget constraint facing each household, in any given period t, is given by:

$$c_t + i_t \le (1-\tau_t)\left[r_t k_t + w_t^o h_t^o + \int_0^{N_t} w_t^i(z) h_t^i(z)dz \right] \tag{2}$$

where: τ_t is the income tax rate in period t, r_t is the rental rate of capital services in period t, w_t^o is the wage rate for labor time devoted to the production of the final good, $w_t^i(z)$ is the wage rate for labor time devoted to the production of services from the z intermediate good in period t.

At the beginning of any given period 0, the representative household seeks a plan of the form $\left\{ c_t, i_t, k_{t+1}, h_t^0, \left\{ h_t^i(z) \right\}_{z\in[0,N_t]} \right\}_{t\in\mathbb{N}_+}$, so as to maximize the lifetime utility function specified above, subject to the budget constraint (2), the capital stock transition equation specified above, the labor time constraint (1), the physical constraints: c_t, k_{t+1}, h_t^0, $h_t^i(z) \ge 0$; $\forall z \in [0, N_t]\,\&\,\forall t \in \mathbb{N}_+$; the initial condition $k_0 \in (0,+\infty)$ and the transversality condition $\beta^t u'(c_t)k_{t+1} \to 0$ as $t \to +\infty$. In so doing, the representative household takes all prices, income tax rates, and numbers of intermediate goods, $\left\{ \left[r_t, w_t^0, \{w_t^i(z)\}_{z\in[0,N_t]} \right]; \left[\tau_t, N_t \right] \right\}_{t\in\mathbb{N}_+}$, as given.

Given the functional forms introduced above and provided that $\left\{ h_t^0, \left\{ h_t^i(z) \right\}_{z\in[0,N_t]} \right\}_{t\in\mathbb{N}_+}$ is chosen in a way that satisfies the physical and time constraints, as well as, being consistent with the representative household's incentives (e.g., utility maximization), a necessary and sufficient condition for a solution to the problem of the representative household is the standard Euler condition: $u'(c_t) = \beta u'(c_{t+1})\left[(1-\delta) + (1-\tau_{t+1})r_{t+1}\right]; \forall t \in \mathbb{N}_+$; or in view of the specific functional form of the temporal utility function, specified above:

$$\frac{c_{t+1}}{c_t} = \left\{ \beta[(1-\delta) + (1-\tau_{t+1})r_{t+1} \right\}^{\frac{1}{\gamma}}; \forall t \in \mathbb{N}_+ \tag{3}$$

Remark 1: Obviously, if $w_t^i(z)$ is different from w_t^0, the household will not be indifferent between h_t^0 and $h_t^i(z)$. If, for example, $w_t^i(z')$, for some z', is greater than w_t^0, the household would prefer $h_t^i(z')$ over h_t^0. Likewise, if $w_t^i(z')$ is greater than $w_t^i(z'')$, for any given z' and z'', the household would prefer $h_t^i(z')$ over $h_t^i(z'')$. In any case, in the solution to the household's problem, (1) will hold with equality. Later, h_t^0 and $\{h_t^i(z)\}_{z\in[0,N_t]}$ will be set following demand conditions and institutional constraints, without violating households' incentives.

2.2 Final Good Producers

Production in the final good sector takes place in a large number of identical firms. As already mentioned, this final good is being produced by means of physical capital services, labor services, and the services of a number of intermediate goods provided by government. In particular, the production technology of the representative firm in this sector is characterized by:

$$Y_t \leq K_t^a (A_t L_t^0)^b \left[\int_0^{N_t} x_t(z)^{\zeta} dz \right]^{\frac{1-a-b}{\zeta}}; \quad a,b > 0,\ a+b<1 \ \&\ \zeta \in (0,1] \tag{4}$$

where: Y_t is output supplied in period *t*, K_t is physical capital services used in period *t*, L_t^0 is labor services used in period *t*, A_t is a parameter that designates the level of (Harrod–neutral) technology at the beginning of period *t* and grows according to: $A_{t+1} = (1+g_A)A_t$, $g_A \in [0,\infty)$; and $x_t(z)$ is the services from the *z* intermediate good used in period *t*. The RHS of (4) is a constant returns to scale production function.

The Dixit-Stiglitz aggregator is used to model the composite of all intermediate good inputs, $\left[\int_0^{N_t} x_t(z)^{\zeta} dz \right]^{(1/\zeta)}$, in a tractable manner. As already noted, we assume that there is a continuum of intermediate good products and that N_t is a positive real number. It can be easily verified that this aggregator belongs to the CES family of production functions, in that it exhibits constant elasticity of substitution across intermediate goods. That is, the elasticity of substitution between any two intermediate goods is $\sigma = \dfrac{1}{1-\zeta}$. Thus, for $\zeta \to 1$, $\sigma \to +\infty$, in which case intermediate goods are perfect substitutes and for $\zeta \to -\infty$, $\sigma \to 0$, in which case, intermediate goods are perfect complements. For $\zeta < 1-a-b$ ($\zeta > 1-a-b$) intermediate goods are gross complements (gross substitutes). For $\zeta = 1-a-b$, the aggregator becomes as in Romer (1990), where the marginal productivity of any given intermediate good is not affected by the input of any other intermediate good. [12] The restriction $\zeta \in (0,1]$ ensures that output increases with the number of intermediate goods, so as to capture the so called "variety" effect, introduced by Romer (1990).

Although we think of intermediate goods as goods provided by government, we do not think of these goods as pure public goods. In particular, we think of intermediate goods as been excludable, in the sense that only those final good producers that pay for using the services from a given intermediate good can use those services. Moreover, these goods are not necessarily nonrival, in the sense that a final good producer that uses the services from a given intermediate good may or may not limit the amount of services used by other final good producers. Actually, most publicly provided services are excludable and to a great extend rival. For example, in many countries basic utilities (electrical power, water and sewage, garbage and waste collection and disposal, stationary telephony and natural gas), transportation networks (railroads, harbors, airports), and various licenses (foods and drugs, fire and flood safety) are provided to their users for a price. Thus, the profits of the representative final good producer are defined as:

$$\pi_t^y = Y_t - r_t K_t - w_t^0 L_t^0 - \int_0^{N_t} p_t(z) x_t(z) dz \tag{5}$$

where $p_t(z)$ is the price for the services of the *z* intermediate good in period *t*.

At the beginning of any given period *t*, the representative final good producer seeks a plan of the form $\left[Y_t, K_t, L_t^0, \{x_t(z)\}_{z\in[0,N_t]}\right]$, so as to maximize its profits, subject to the production technology constraint (4) and the physical constraints: $Y_t,\ K_t,\ L_t^0,\ x_t(z) \geq 0$; $\forall z \in [0, N_t]$ & $\forall t \in \mathbb{N}_+$. In so doing, the representative final good producer takes all prices and the number of intermediate good producers, $\left\{\left[r_t, w_t^0, \{p_t(z)\}_{z\in[0,N_t]}\right]; N_t\right\}_{t\in\mathbb{N}_+}$, as given.

Given the functional form of the production technology, the following is a set of necessary and sufficient conditions for a solution to the problem of the representative final good producer:

$$Y_t = K_t^\alpha (A_t L_t^0)^b \left[\int_0^{N_t} x_t(z)^\zeta dz\right]^{\frac{1-\alpha-b}{\zeta}} \tag{6}$$

$$aK_t^{a-1}(A_t L_t^0)^b \left[\int_0^{N_t} x_t(z)^\zeta dz\right]^{\frac{1-\alpha-b}{\zeta}} = r_t \tag{7}$$

$$bK_t^\alpha (A_t L_t^0)^{b-1} \left[\int_0^{N_t} x_t(z)^\zeta dz\right]^{\frac{1-\alpha-b}{\zeta}} = w_t^0 \tag{8}$$

---

[12] That is, $[\partial^2 Y_t / \partial x_t(z')\partial x_t(z'')] \gtreqless 0$ as $\zeta \lesseqgtr 1 - a - b$; $\forall z', z'' \in [0, N_t] \ni z' \neq z''$.

$$(1-a-b)K^{a}(A_tL_t^0)^b\left[\int_0^{N_t} x_t(z')^{\zeta}dz'\right]^{\frac{1-\alpha-b-\zeta}{\zeta}} x_t(z)^{\zeta-1} = p_t(z);\ \forall z\in[0,N_t]. \tag{9}$$

As (9) makes clear, the (inverse) demand for the services from the *z* intermediate good increases (decreases) with the composite of all intermediate good inputs, $\left[\int_0^{N_t} x_t(z')^{\zeta}dz'\right]^{(1/\zeta)}$ or, for that matter, with any given intermediate good $z'\in[0,N_t]$, if and only if $\zeta<1-a-b$ ($\zeta>1-a-b$). That is, if and only if intermediate goods are gross complements (gross substitutes). Clearly, however, gross complementarity is more compatible with the idea of public intermediate goods being basic utilities, transportation networks, licenses, etc. As it turns out, whether intermediate goods are gross complements or gross substitutes, is crucial for the workings of this model. However, it is more convenient to raise this issue, again, further below, where the implications of gross complementarity will be apparent.

Remark 2: The reason we have not included dividends from final good producers in the households' budget constraint (2), is the CRS production function. For, substituting (6)-(9) into (5) gives: $\pi_t^Y = Y_t - aY_t - bY_t - (1-a-b)Y_t = 0$, $\forall t\in\mathbb{N}_+$.

2.3 Intermediate Good Service Producers

Services of intermediate goods are produced using labor time. In particular, the production technology for the services from the *z* intermediate good is characterized by:

$$X_t(z)\le\Phi(z)A_tL_t^i(z);\ \Phi(z)\in(0,\infty),\ \forall z\in[0,N_t)\ \&\ t\in\mathbb{N}_+ \tag{10}$$

where: $X_t(z)$ is output supplied in period *t* and $L_t^i(z)$ is labor services used in period *t*. The RHS of (10) is also a CRS production function, that incorporates the assumptions of the same Harrod-neutral technological progress across all intermediate goods as in the final good sector and, in addition, Ricardian productivity differences in any given period, across intermediate goods. In particular, the same Harrod – neutral technological progress, here, is consistent with considering labor services offered to the final good and the intermediate good sectors as being identical.[13]

Further, we define the profits of the representative producer of services from the *z* intermediate good as:

$$\pi_t^x(z) = p_t(z)X_t(z) - w_t^i(z)L_t^i(z) \tag{11}$$

[13] Physical capital can be easily introduced in (10) without changing any of the results in this subsection, for its quantity would have been taken as given by intermediate good service producers. More on this after the introduction of the government budget constraint.

At the beginning of any given period *t*, the representative producer of services from the *z* intermediate good seeks a plan of the form $\left\{p_t(z), X_t(z), L_t^i(z)\right\}$, so as to achieve zero profits, subject to the production technology constraint (10), the demand for its services (9) and the physical constraints: $X_t(z), L_t^i \geq 0; \quad \forall z \in [0, N_t] \ \& \ \forall t \in \mathbb{N}_+$. In so doing, the representative producer of services from the *z* intermediate good takes all wages and the number of intermediate good producers, $\left\{w_t^i(z), N_t\right\}_{t\in\mathbb{N}_+}$, as given.[14]

Given the functional form of the production technology, the following is a set of necessary and sufficient conditions for a solution to the problem of the representative producer of services from the *z* intermediate good:

$$X_t(z) = \Phi(z) A_t L_t^i(z) \tag{12}$$

$$(1-a-b) A_t^{1-a} K_t^{\alpha} L_t^{0b} \left\{ \int_0^{N_t} [\Phi(z') L_t^i(z')]^{\zeta} dz' \right\}^{\frac{1-\alpha-b-\zeta}{\zeta}} \Phi(z)^{\zeta} L_t^i(z)^{\zeta-1} = w_t^i(z) \tag{13}$$

The preceding equation is a straightforward implication of the fact, that the *z* intermediate good service producers will employ so much labor, so that the marginal revenue product of labor be equal to the wage rate: $p_t(z)\Phi(z) A_t = w_t^i(z)$. As the following remark explains, (13) is, also, the (inverse) aggregate demand for labor in the production of services from the *z* intermediate good. Clearly, this demand increases (decreases) with the weighted average of the labor input in the production of services of all intermediate goods, $\left\{ \int_0^{N_t} [\Phi(z') L_t^i(z')]^{\zeta} dz' \right\}^{\frac{1}{\zeta}}$, if and only if intermediate goods are gross complements (gross substitutes).

<u>Remark 3</u>: The number of final good producers is irrelevant, in this model, due to the CRS production function in (4) and perfect competition. Moreover, the number of *z* intermediate good service producers is also irrelevant due to the CRS production function in (10) and the zero profit restriction. Thus, without loss of generality, in deriving (13), it has been assumed that these numbers are both one.

At any rate, this formulation is consistent with the Southern European model, where public utilities, transportation networks, and other publicly provided services are supplied by a single agency/firm that has a monopoly, but is heavily regulated. However, these agencies/firms end up

[14] This is not a crucial assumption and the propositions of this paper would go through with publicly provided intermediate good service producers having some other objective, like regulated profits. For simplicity purposes, this is not pursued in this paper.

behaving like unregulated monopolist, due to the behavior of the union that controls their labor input. Thereby, having relatively high prices and relatively low output (quality).[15]

2.4 Insiders' Unions

Labor used in the production of services from each intermediate good *z* is organized in a (trade) union. That is, there is a separate union *z* for each intermediate good z, for all z. For reasons, that will be apparent shortly, we refer to these unions as "insiders' unions." Following the standard union literature, we assume that the preferences of the *z* union of insiders are characterized by a utility function of the form $\sum_{t=0}^{\infty} \beta^t \left[w_t^i(z) - w_t^0 \right]^{\lambda(z)} L_t^i(z);\ \lambda(z) \in (0,1), \forall z \in [0, N_t]\ \&\ t \in \mathbb{N}_+$. This form of union preferences corresponds to the "utilitarian" model of McDonald and Solow (1981) and Oswald (1982), where the representative union member has a constant relative rate of risk aversion, provided that union membership is fixed. These assumptions are consistent with the set up of the household problem, defined in Subsection 2.1. In fact, as the household problem formulation implies (Remark 1), union membership is determined by the union and is fixed and equal to employment in the production of services of the corresponding intermediate good sector.[16] Further, w_t^0 is the "alternative wage" for insiders, in the sense that, $w_t^i(z) - w_t^0$ is the wage premium of insiders over outsiders and at the same time the wage premium in the public sector. The latter, as already noted, are all those that work in the final good sector of the economy. And, finally, $\lambda(z)$ is a parameter that measures the relative preference of the wage premium over employment for the *z* union of insiders.

At the beginning of any given period *t*, the *z* union of insiders seeks a plan of the form $\left\{ w_t^i(z), L_t^i(z) \right\}_{t \in \mathbb{N}_+}$, so as to maximize its utility, defined in the preceding paragraph, subject to the aggregate demand for labor in the production of services from the *z* intermediate good (13), the physical constraints: $w_t^i(z),\ L_t^i(z) \geq 0$; and, the institutional constraint: $L_t^i(z) > 0$, if and only if $w_t^i(z) > w_t^o$; $\forall z \in [0, N_t]\ \&\ \forall t \in \mathbb{N}_+$. In so doing, the *z* union of insiders takes the aggregate capital, the aggregate employment of outsiders, the wage and employment choices of all other unions of

[15] A classic example is the Greek Power Company (ΔΕΗ), which although a de facto monopoly, has more or less zero profits, but its labor union (ΓΕΝΟΠ-ΔΕΗ) has substantial market and political power, that results in substantial wage premiums and other benefits for its members (See, e.g., Michas (2011), for a narrative).

[16] Although our formulation of households allocating time among final and intermediate good sectors is admittedly a highly schematic one, if so preferred the reader may think of households having many members, where some are insiders and others are outsiders. At any rate, the profoundly important income distribution effects of the insiders–outsiders society are thereby ignored. And, as is, of course, the important question of who becomes an insider and who ends up as an outsider, in the presence of these income distribution effects. However, introducing fixed numbers of outsiders and insiders, under complete union insurance, would not change any of the results of this paper, although it would complicate the notation considerably. More on this, in the last section.

insiders and the number of intermediate good producers, $\left[K_t, L_t^0, \{w_t^i(z'), L_t^i(z')\}_{z' \in [0,N_t] \setminus \{z\}}, N_t\right]$, as given.

Let $\eta_t(z) \equiv -\frac{\partial L_t^i(z)}{\partial w_t^i(z)} \frac{w_t^i(z)}{L_t^i(z)}$ be the elasticity of the demand for labor facing the z-union of insiders. Then, provided that $\eta_t(z) > \lambda(z)$, as we shall ensure below (i.e., through [R1], below), there exists a unique solution to the problem of the z- union of insiders, which is interior (i.e., $w_t^i(z) > w_t^o$, $L_t^i(z) > 0$) and such that:

$$\frac{w_t^i(z)}{w_t^o} = \frac{1}{1 - \frac{\lambda(z)}{\eta_t(z)}} \tag{14}$$

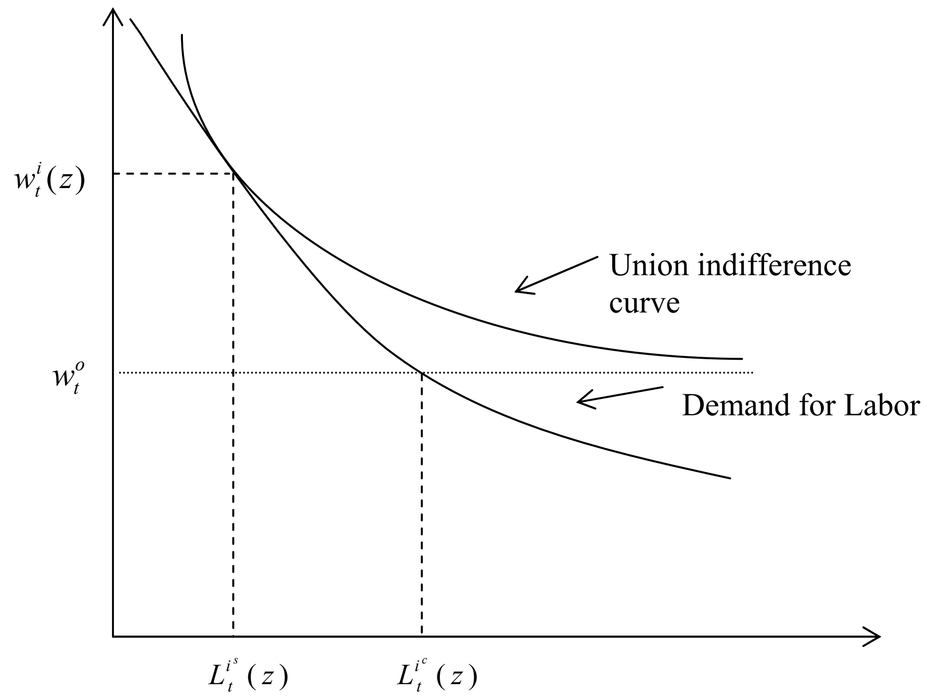
This is the well known tangency condition of the union indifference curve and the demand for labor facing that union (See Figure 4, below).

<u>Remark 4</u>: Given $\eta_t(z) > \lambda(z)$, the tangency condition (14) happens at a point where $w_t^i(z) > w_t^o$ and where $L_t^i(z)$ is less than the employment level that corresponds to a situation where $w_t^i(z) = w_t^o$.[17]

Not surprisingly, although all union members are employed, the union restricts employment, and hence union membership, in order to raise the wage rate enjoyed by its members. This, of course, implies an important "misallocation" effect of the insiders-outsiders society. This friction has profound implications for both output and growth. It will be more convenient, however, to examine the important implications of this effect, as well as, the restrictions imposed upon the model's parameters by the condition $\eta_t(z) > \lambda(z)$, after the model's structure has been completed. Again, however, this is consistent with the Southern European economic model, where the workers of publicly provided intermediate goods are organized in powerful labor unions, and the corresponding intermediate good producers are heavily regulated.

[17] Observe that, $1/\lambda(z) = -\frac{d[w_t^i(z) - w_t^o]}{dL_t^i(z)} \frac{L_t^i(z)}{w_t^i(z) - w_t^o}$ is the elasticity along the indifference curves of the *z*-union of insiders in the $\left[L_t^i(z),\ w_t^i(z) - w_t^o\right]$ space and $1/\eta_t(z) = -\frac{dw_t^i(z)}{dL_t^i(z)} \frac{L_t^i(z)}{w_t^i(z)}$, is the elasticity of the inverse demand curve for labor faced by the z-union of insiders. Thus, if in the solution to the problem of the *z*-union of insiders the slopes of these two curves must be the same, we must have: $\frac{w_t^i(z)}{w_t^o} = [1/\lambda(z)] / \{[1/\lambda(z)] - [1/\eta_t(z)]\}$. Hence, $\eta_t(z) > \lambda(z)$ implies that $w_t^i(z) > w_t^o$. Now, the last fact and the fact that $\eta_t(z) > 0$, implies that the employment that corresponds to w_t^o , $L_t^{i^c}(z)$, is greater than $L_t^i(z)$ (See Figure 4).

Figure 4: An illustration of the solution to the problem of the z-union of insiders



2.5 Government

The Government's budget constraint, expressed in representative household units, in any given period t, is given by:

$$\int_{N_t}^{N_{t+1}} \tilde{\Psi}_t(z)dz + \int_0^{N_t} \hat{\Psi}_t(z)dz = \tau_t \left[r_t k_t + w_t^0 h_t^0 + \int_0^{N_t} w_t^i(z) h_t^i(z)dz \right] \tag{15}$$

where $\tilde{\Psi}_t(z)$ is the cost of setting up (dismantling) new (old) z-intermediate good infrastructure in period t and $\hat{\Psi}_t(z)$ is the cost of administering and maintaining the existing z-intermediate good infrastructure in period t. That is, the first term in the LHS of (15) should be thought of as the investment cost of new infrastructure and the second term in the LHS of (15) as the cost of maintaining the existing infrastructure.[18] $\tilde{\Psi}_t(z)$ and $\hat{\Psi}_t(z)$ will be further specified, shortly.

[18] The introduction of public capital would make equation (15) much less abstract. For example, investment in new publicly provided capital infrastructure could take the form $\int_{N_t}^{N_{t+1}} \tilde{\Psi}_t(\cdot,z) i_t^g(z)dz$, where $\tilde{\Psi}_t(\cdot,z)$ and $i_t^g(z)$ stand for the unit cost and investment quantity of the new z-intermediate good infrastructure in period t, respectively. And, maintenance of existing publicly provided capital infrastructure could take the form $\int_0^{N_t} \hat{\Psi}_t(\cdot,z) k_t^g(z)dz$, where $\hat{\Psi}_t(\cdot,z)$ and $k_t^g(z)$ stand for the unit cost and capital stock of the old z-intermediate good infrastructure in period t, respectively. Depending on where one wants to focus, $\hat{\Psi}_t(\cdot,z)$ and $\tilde{\Psi}_t(\cdot,z)$ could be specified accordingly. For example, in order to capture adjustment costs in investment quantity, $\tilde{\Psi}_t(\cdot,z)$ could be made to depend on $i_t^g(z)$ and to capture adjustment

2.6 Equilibrium

An equilibrium for this economy is defined as a sequence of the form:

$$\Big\{\Big[c_t, i_t, k_{t+1}, h_t^0, \{h_t^i(z)\}_{z\in[0,N_t]}\Big]; \Big[Y_t, K_t, L_t^0, \{x_t(z)\}_{z\in[0,N_t]}\Big]; \Big[\{p_t(z), X_t(z), L_t^{i^d}(z)\}_{z\in[0,N_t]}\Big]; \Big[\{w_t^i(z), L_t^{i^s}(z)\}_{z\in[0,N_t]}\Big];$$

$$\Big[r_t, w_t^0, \{p_t(z), w_t^i(z)\}_{z\in[0,N_t]}\Big]; \Big[\tau_t, N_{t+1}^i\Big]\Big\}_{t\in\mathbb{N}_+}$$

such that:

(I) Given $\Big\{\Big[r_t, w_t^0, \{w_t^i(z), L_t^{i^s}(z)\}_{z\in[0,N_t]}\Big], [\tau_t, N_{t+1}]\Big\}_{t\in\mathbb{N}_+}$, $\Big\{\Big[c_t, i_t, k_{t+1}, h_t^0, \{h_t^i(z)\}_{z\in[0,N_t]}\Big]\Big\}_{t\in\mathbb{N}_+}$ is a solution to the representative household's problem, such that:

$$h_t^i(z) = L_t^{i^s}(z), \quad \forall z \in [0, N_t\,] \;\&\; t \in N_+ \tag{16}$$

$$h_t^0 = \overline{h} - \int_0^{N_t} h_t^i(z) \tag{17}$$

(II) Given $\Big[r_t, w_t^0, \{p_t(z)\}_{z\in[0,N_t]}\Big]$, $\Big[Y_t, K_t, L_t^0, \{x_t(z)\}_{z\in[0,N_t]}\Big]$ is a solution to the representative final good producer's problem.

(III) Given $w_t^i(z)$, $\Big[p_t(z), X_t(z), L_t^{i^d}(z)\Big]$ is a solution to the *z*–intermediate good service producer's problem, for all $z \in [0, N_t\,]$ and $t \in \mathbb{N}_+$.

(IV) Given $\Big[K_t, L_t^0, w_t^0\Big]$ and $\Big[w_t^i(z'), L_t^{i^s}(z')\Big]_{z'\in[0,N_t^i]/\{z\}}$, $[w_t^i(z), L_t^{i^s}(z)]$ is a solution to the problem of the *z*–union of insiders, for all $z \in [0, N_t\,]$.

(V) Given the solutions to: the representative household's problem, the representative final good producer's problem, each intermediate good producer's problem, the problem of each insiders' union and government's choices $\{\tau_t, N_{t+1}^i\}_{t\in\mathbb{N}_+}$, the price sequence $\Big\{r_t, w_t^o, \{p_t^i(z), w_t^i(z)\}_{z\in[0,N_t]}\Big\}_{t\in\mathbb{N}_+}$ is such that, all markets clear in each and every period t, $t \in \mathbb{N}_+$:

$$Y_t = c_t + i_t + \int_{N_t}^{N_{t+1}} \tilde{\Psi}_t(z)dz + \int_0^{N_t} \hat{\Psi}_t(z)dz \equiv y_t \tag{18}$$

$$K_t = k_t \tag{19}$$

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costs in varieties, $\tilde{\Psi}_t(\cdot, z)$ could be made to depend on *z*, etc. Likewise, to capture vintage capital, $\hat{\Psi}_t(\cdot, z)$ could be made to depend on $u \in \mathbb{N}_+$, such that $z \in (N_u, N_{u+1})$ for all $u \le t$. And, to capture depreciation, $\hat{\Psi}_t(\cdot, z)$ could be made to depend on $t - u$. We have avoided these complications here, to focus on the essence of the insiders–outsiders society.

$$L_t^0 = h_t^o \tag{20}$$

$$x_t(z) = X_t(z), \qquad \forall z \in [0, N_t] \tag{21}$$

$$L_t^{i^d}(z) = L_t^{i^s}(z), \ \forall z \in [0, N_t] \tag{22}$$

(VI) All agents "expectations" about $\{\tau_t, N_{t+1}\}_{t \in \mathbb{N}_+}$ are realized, in the sense that the government budget constraint, (15), is satisfied.

Conditions (16) and (17) in prerequisite I, justify the claim made at the end of Remark 1. And, prerequisite V implies that the unions play Nash against each other. Finally, prerequisite VI, implies that all agents have rational expectations.

As noted in Remark 3, the numbers of households, final good producers, and *z*-intermediate good producers *z* are irrelevant in this model. For representation purposes, however, the market equilibrium equations, (18) – (22) make sense only under the assumptions of this Remark.

For tractability purposes, in what follows we shall characterize the equilibrium in the symmetric case, where there are no differences across intermediate good service producers, the corresponding insiders' unions, and the distributions of $\Phi(z)$, $\hat{\Psi}_t(z)$ and $\hat{\Psi}_t(z)$ are uniform.

2.7 The Symmetric Case

Suppose that:

$$\Phi(z) = \Phi; \ \Phi > 0, \ z \in [0, N_t] \tag{23}$$

$$\lambda(z) = \lambda; \ \lambda \in (0,1), \ \forall z \in [0, N_t] \ \& \ t \in \mathbb{N}_+ \tag{24}$$

$$\tilde{\Psi}_t(z) = \tilde{\psi} y_t; \quad \tilde{\psi} > 0 \tag{25}$$

$$\hat{\Psi}_t(z) = \hat{\psi} y_t; \quad \hat{\psi} > 0 \tag{26}$$

The last two restrictions make investment in new infrastructure and maintenance of existing infrastructure, fixed functions of output per efficient household. Obviously, these are strong restrictions for analyzing business cycle effects. But, herebelow, they are not so restrictive, as we limit our attention in steady states and convergence towards these steady states.

Then, the equilibrium of this economy is completely characterized by the following set of equations, along with the initial and transversality conditions of Subsection 2.1:

$$\frac{c_{t+1}}{c_t} = \{\beta(1+g_A)^{-1}[(1-\delta)+(1-\tau)r_{t+1}]\}^{\frac{1}{\gamma}} \tag{27}$$

$$k_{t+1} = (1+g_A)^{-1}[(1-\delta)k_t + i_t] \tag{28}$$

$$h_t^0 + N_t h_t^i = \overline{h} \tag{29}$$

$$y_t = \Phi^{1-\alpha-b} N_t^{\frac{(1-\alpha-b)(1-\zeta)}{\zeta}} k_t^{\alpha} h_t^{0^b} (N_t\ h_t^i)^{1-\alpha-b} \tag{30}$$

$$r_t = \alpha \frac{y_t}{k_t} \tag{31}$$

$$w_t^o = b \frac{y_t}{h_t^0} \tag{32}$$

$$w_t^i = (1-\alpha-b)\ \frac{y_t}{N_t h_t^i} \tag{33}$$

$$\nu(\mathrm{N}_t) \equiv \frac{w_t^i}{w_t^0} = \frac{1}{1-\lambda[(1-\zeta) - \frac{1-\alpha-b-\zeta}{N_t}]} \tag{34}$$

$$\tilde{\psi}(N_{t+1} - N_t) + \hat{\psi} N_t = \tau_t \tag{35}$$

$$y_t = c_t + i_t + \tilde{\psi} y_t (N_{t+1} - N_t) + \hat{\psi} y_t N_t \tag{36}$$

where c_t, i_t, k_t, y_t in (27)-(36) and henceforth, are equal to c_t, i_t, k_t, y_t of (1)-(26), respectively, divided by $A_t \overline{h}$. And, w_t^0, w_t^i in (27)-(36) and henceforth, are equal to w_t^0, w_t^i of (1)–(26), respectively, divided by A_t. Equation (34) defines the "relative wage premium" of insiders over the outsiders. Equation (35) is the government budget constraint and (36) is the economy's resource constraint. Equations (27) – (36) form a system of ten equations in ten unknowns (i.e., $c_t, i_t, h_t^0, N_t h_t^i, y_t, k_t, r_t, w_t^0, w_t^i$ and N_t).

For fixed N_t, this system of equations is a standard neoclassical growth model, that converges monotonically to a unique interior steady state $c, i, h^0, Nh^i, y, k, r, w^0, w^i$. In what follows, we examine the properties of this model first for fixed N_t and then for variable N_t. Finally, observe from (30) that, ceteris paribus, output rises with the number of intermediate goods, N_t, as long as $\zeta \in (0,1)$. That is, as long as there is a "variety" effect.

3. THE WORKINGS OF THE MODEL

3.1 The Relative Wage Premium

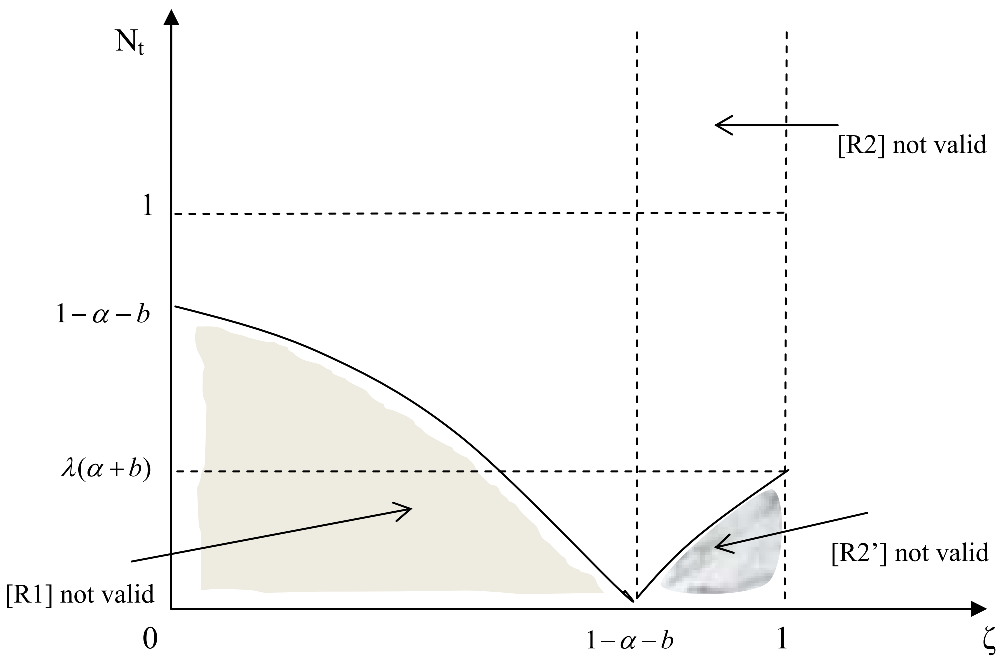
To ensure that the relative wage premium is positive and greater than one, we need the following restrictions:

[R1] $$1 - \zeta - \frac{1-\alpha-b-\zeta}{N_t} > 0$$

[R2'] $$\lambda[\,1-\zeta-\frac{1-\alpha-b-\zeta}{N_t}\,]<1$$

In particular, [R1] implies that the elasticity of demand for labor faced by the representative union of insiders, $\eta_t \equiv -\frac{\partial L_t^i}{\partial w_t^j}\frac{w_t^j}{L_t^i} = 1/[1-\zeta-\frac{1-\alpha-b-\zeta}{N_t}]$ is positive. This, of course, implies that the labor demand of intermediate good service producers is downward slopping. As can be seen from Equation (34), [R1], ensures that the relative wage premium, if positive, is greater than one. Technically, if N_t is greater than or equal to $1-\alpha-b$, [R1] does not impose any further restrictions on the model's parameters.[19] And, if $N_t \in (0,1-\alpha-b)$, [R1] places a lower bound on ζ, as illustrated in Figure 5, below.

Figure 5: An illustration of the restrictions on the model's parameters



Clearly, [R2'] implies that the relative wage premium is positive. Technically, if N_t is greater than or equal to $\lambda(\alpha+b)$, [R2'] does not impose any further restrictions on the model's parameters.[20] And, if $N_t \in (0,\lambda(\alpha+b))$, [R2'] places an upper bound on ζ. This upper bound is greater than $1-\alpha-b$, as indicated in Figure 5, above.

Further, it follows from (34), that:

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[19] Let $N_t = (1-a-b)+\varepsilon,$ for some $\varepsilon \geq 0$. And, observe that [R1] holds if and only if $\zeta(a+b)+\varepsilon(1-\zeta)>0$, which is true always.

[20] Let $N_t = \lambda(a+b+\varepsilon),$ for some $\varepsilon \geq 0$. And, observe that [R2'] holds if and only if $\lambda(a+b)-1<\{[1/(1-\zeta)]-\lambda\}\varepsilon$, which is true always, given the facts that $0<(a+b),\lambda,\zeta<1$.

$$\nu'(N_t) = \lambda(1-a-b-\zeta)\frac{\nu(N_t)^2}{N_t^{\,2}} \tag{37}$$

Hence, the sign of $\nu'(N_t)$ is the sign of $1-a-b-\zeta$. That is, a necessary and sufficient condition for $\nu'(N_t)$ positive (negative) is that intermediate goods are gross complements (substitutes). For reasons already explained in the previous section, in the remainder of this paper, we shall assume that intermediate goods are gross complements:

[R2] $\zeta \leq 1-a-b$

Also, observe that, [R2] implies [R2'] is satisfied (See Figure 5). Summarizing results, we have shown the following:

Proposition 1: *(a) Given [R1] and [R2'],* $\nu(N_t):(0,+\infty)\rightarrow\left(1, 1/\left[1-\lambda(1-\zeta)\right]\right)$ *and is greater: (i) the greater the relative preference of the wage premium over employment in the union utility function, λ; and (ii) the lower the elasticity of labor demand facing intermediate good service producers,* $1\Big/\left[1-\zeta-\dfrac{1-\alpha-b-\zeta}{N_t}\right]$. *(b) Given [R2],* $\nu'(N_t)$ *increases with the degree intermediate goods are gross complements,* $1-\alpha-b-\zeta$.

The economic rationale behind the results of Proposition 1 is straightforward. The wage premium is a consequence of the organization of the labor market. And, in particular, of the market power enjoyed by insiders' unions. Now, as the following remark makes clear, if there was no wage premium, there is no distortion. But, first note that in the symmetric equilibrium case, (29) and (32)-(34) reduce to:

$$h_t^o = \frac{b\,\nu(N_t)}{b\,\nu(N_t)+(1-a-b)}\bar{h} \tag{38}$$

$$N_t\,h_t^i = \frac{(1-\alpha-b)}{b\nu(N_t)+(1-\alpha-b)}\bar{h} \tag{39}$$

And, therefore

$$\frac{N_t h_t^i}{h_t^o} = \frac{1-a-b}{b\nu(N_t)} \tag{40}$$

Remark 5: (a) Equation (40) implies that the ratio of employment in the services of publicly provided intermediate goods (i.e., public employment) and employment in the final good (i.e., private employment) is inversely related to the wage premium in the public sector.

(b) Suppose, now, that labor input in the production of services of intermediate goods is supplied competitively. Then, since labor services are identical, equilibrium in the labor market implies $w_t^i = w_t^o$ and h_t^o and h_t^i are set so that the marginal products of labor in the final good sector and the services of the intermediate goods sector are equal to the common (real) wage rate. In this case it follows from (38)-(39) that:

$\frac{N_t h_t^i}{h_t^o} = \frac{1-a-b}{b}$ and since $h_t^0 + N_t h_t^i = \overline{h}$, $h_t^o = \frac{b}{1-a}\overline{h}$ and $N_t h_t^i = \frac{1-a-b}{1-a}\overline{h}$.

The latter is the maximum amount of labor that can be devoted to the production of services from the publicly provided intermediate goods. The same will hold true (i.e., $v(N_t) = 1$) in this model, under two possibilities. First, when $\lambda = 0$, that is when the union does not care about the wage premium. And second, when $\eta = +\infty$, that is when the union faces an horizontal demand for labor.

(c) For $v(N_t) > 1$, the monopolistic unions restrict labor input, so as to receive a higher wage rate.

The last result is what we shall refer to as the "labor misallocation" effect.[21]

3.2 The relative wage premium, TFP, and output.

We turn now to the implications of this "labor misallocation" effect.

Let $y_t = \xi(N_t)k_t^a$, where:

$$\xi(N_t) \equiv \frac{b^b(1-a-b)^{(1-a-b)}\Phi^{(1-a-b)}}{(1-a)^{(1-a)}} N_t^{\frac{(1-a-b)(1-\zeta)}{\zeta}} \frac{v(N_t)^b}{\left\{1+\frac{b}{1-a}\left[v(N_t)-1\right]\right\}^{1-a}} \tag{41}$$

Recall that y_t and k_t are output and capital per efficient household, respectively, so that $\xi(N_t)$ is total factor productivity (TFP). Given Proposition 1, $\xi(N_t)$ is positive. Observe that N_t affects $\xi(N_t)$ both directly, through the middle term in the RHS of (41) and, indirectly, through the relative wage premium, $v(N_t)$. The direct effect of N_t on $\xi(N_t)$ is positive and relates to the production technology assumed. And, in particular, the property of the production function that, as long as intermediate goods are not perfect substitutes (i.e., $0 < \zeta < 1$), an increase in the number of intermediate goods, increases TFP and output. For, each intermediate good input is subject to diminishing returns to scale and, therefore, for any given amount of the aggregate input, $N_t x_t$, more output is produced if there are more intermediate goods, N_t, composing this aggregate input.

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[21] Much like the standard insiders-outsiders labor market theory suggests, this model can easily account for outsiders' unemployment, by introducing a minimum wage rate which is greater than w_t^0. In fact, the higher the wage premium in the public sector, the stronger the "misallocation" effect and the lower the demand for outsiders labor, implying greater unemployment amongst outsiders, for any given minimum wage rate.

As already mentioned, this is what is referred to as the "love-for-variety" effect or simply "variety" effect in the growth literature.[22] The indirect effect relates to the relative wage premium being greater one, for if the wage premium is one, the last term in the RHS of (41) becomes unity. This effect is negative. To check this, we look at the change in $\xi(N_t)$ brought about by a change in the relative wage premium that does not emanate from a change in N_t (i.e., $\left.\frac{\partial \xi}{\partial \nu}\right|_{N_t\ fixed}$) and the change in $\xi(N_t)$ brought about by a change in N_t (i.e., $\xi'(N_t)$). It follows from (41) that $\left.\frac{\partial \xi}{\partial \nu}\right|_{N_t\ fixed} \gtreqless 0$ as $1+\frac{b}{1-a}(\nu-1) \gtreqless \nu$. Given [R1] and [R2], $\nu>1$. But, for $\nu>1$, $1+\frac{b}{1-a}(\nu-1)<\nu$. Therefore, given [R1] and [R2], $\left.\frac{\partial \xi}{\partial \nu}\right|_{N_t\ fixed}<0$. Hence, the overall effect on $\xi(N_t)$ of a change in N_t is not obvious. Herebelow, we summarize results and we show that the overall effect on $\xi(N_t)$ of a change in N_t is positive.

<u>Proposition 2</u>: *Given [R1] and [R2],* $\xi(\mathrm{N}_t):(0,+\infty)\rightarrow(0,+\infty)$, *such that: (a)* $\left.\frac{\partial \xi}{\partial \nu}\right|_{N_t\ fixed}<0$, *and (b)* $\xi'(N_t)>0$, $\forall\,\mathrm{N}_t\in(0,+\infty)$.

<u>Proof</u>: The proof of the last part is in the Appendix.

Hence, given gross complementarity (i.e., [R2]) and unions facing downward sloping labor demand (i.e., [R1]), the "variety" effect dominates the "labor misallocation" effect.

To further illustrate the implications of this "labor misallocation" effect, associated with the equilibrium considered in the previous subsections, it is instructive to consider the Second Best associated with this equilibrium. In this model, there are two reasons that the equilibrium is not Pareto Optimum: Proportional income taxes and the market power of the insiders' unions. Thus, we shall focus our attention to characterizing efficiency losses with respect to a "Second Best" outcome. That is, when there is no insiders-outsiders organization of society, but there is a "tax distortion" effect. In this case, of course, there are no insiders' unions and there is no relative wage premium, nor a "labor misallocation" effect. Formally, we define as a "Second Best" outcome for this economy an equilibrium, where the relative wage premium $\nu^{SB}(N_t)=1$, for all $t\in\mathbb{N}_+$. Clearly,

[22] See, e.g., Acemoglu (2009, Ch. 12).

if income taxes were lump sum, the Second Best, defined above, would coincide with the Pareto Optimum, by virtue of the First Fundamental Theorem of Welfare Economics. Now, the Second Best is also characterized by (27) – (36), with TFP given by:

$$\xi^{SB}(N_t) \equiv \frac{b^b(1-a-b)^{(1-a-b)}\Phi^{(1-a-b)}}{(1-a)^{(1-a)}} N_t^{\frac{(1-a-b-\zeta)(1-\zeta)}{\zeta}} \tag{42}$$

Let:

$$\pi(N_t) \equiv \xi^{SB}(N_t) - \xi(N_t)$$

$$= \frac{b^b(1-a-b)^{(1-a-b)}\Phi^{(1-a-b)}}{(1-a)^{(1-a)}} N_t^{\frac{(1-a-b-\zeta)(1-\zeta)}{\zeta}} \left(1 - \frac{v(N_t)^b}{\left\{1+\frac{b}{1-a}\left[v(N_t)-1\right]\right\}^{1-a}} \right) \tag{43}$$

We may think of $\pi(N_t)$ as the TFP gap due to the "labor misallocation" effect. Clearly, this TFP gap is proportional to the corresponding output gap, $y_t^{SB} - y_t = \pi(N_t)k_t^a$. This is a measure of the equilibrium efficiency losses relative to the Second Best, where there is no insiders-outsiders organization of society.

First, we must characterize the sign of $\pi(N_t)$ and second, the change of $\pi(N_t)$. As in the case of $\xi(N_t)$, it is useful to distinguish between two effects: The change in $\pi(N_t)$ brought about by a change in the relative wage premium that does not emanate from a change in N_t (i.e., $\left.\frac{\partial \pi}{\partial v}\right|_{N_t \text{ fixed}}$) and the change in $\pi(N_t)$ brought about by a change in N_t (i.e., $\pi'(N_t)$).

<u>Proposition 3</u>: *Given [R1] and [R2],* $\pi(N_t):(0,+\infty)\to(0,+\infty)$, $\left.\frac{\partial \pi}{\partial v}\right|_{N_t \text{ fixed}}$ *> 0, and* $\pi'(N_t) > 0$, $\forall \mathrm{N}_t \in (0,+\infty)$.

<u>Proof</u>: In the Appendix.

Hence, the "misallocation effect" increases with both the public sector wage premium and the number of publicly provided intermediate goods.

Next, we turn to the question of how the number of publicly provided intermediate goods affects capital, output and growth. As already mentioned, there are two ways to look into the answer to this question: with a fixed and a variable number of publicly provided intermediate goods. Naturally the analysis starts with a fixed (given) number of publicly provided intermediate goods.

3.3 The Steady State and Comparative Statics with a Fixed Number of Publicly Provided Intermediate Goods

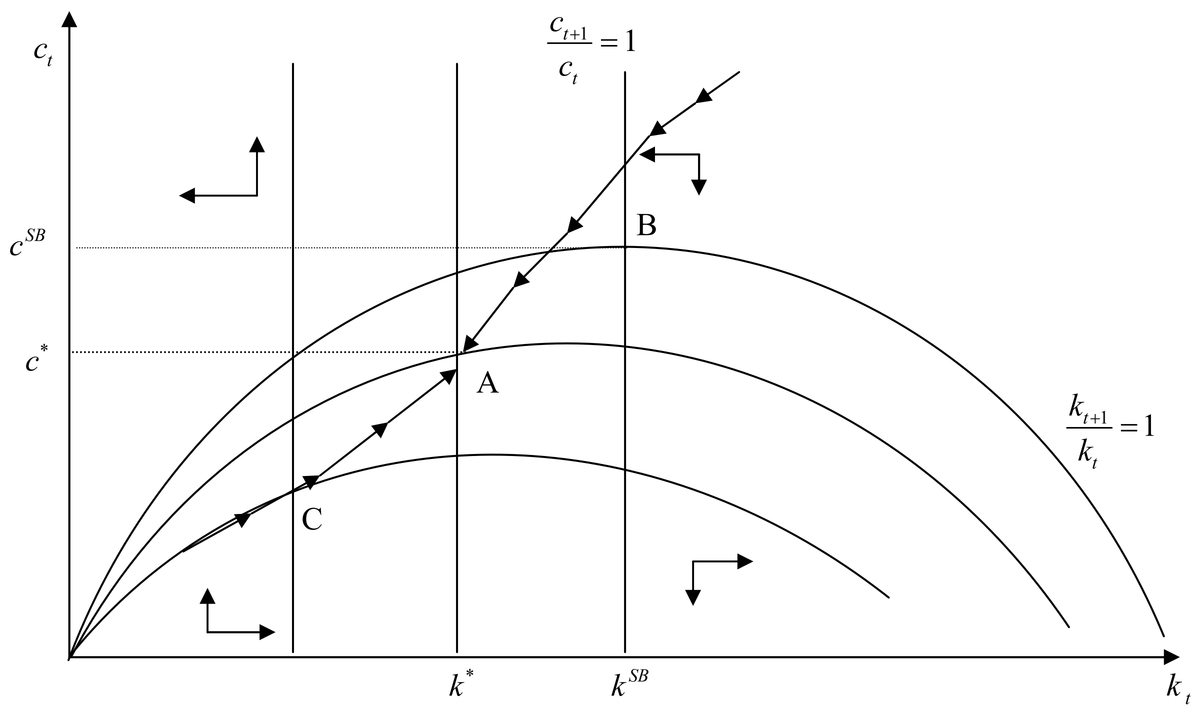
In the case where N_t is fixed, say, $N_t = \bar{N}$, such that $\hat{\psi}\bar{N} \in (0,1)$, $\forall t \in \mathrm{N}_+$, the transitional dynamics of the equilibrium are characterized as in the standard neoclassical growth model, by two difference equations and two side conditions.[23] That is,

$$\frac{c_{t+1}}{c_t} = \left\{\beta(1+g_A)^{-1}\left[(1-\delta)+\alpha(1-\tau)\xi(\bar{N})k_{t+1}^{\alpha-1}\right]\right\}^{\frac{1}{\gamma}} \tag{44}$$

$$\frac{k_{t+1}}{k_t} = (1+g_A)^{-1}\left\{(1-\delta)+k_t^{-1}\left[(1-\hat{\psi}\bar{N})\xi(\bar{N})k_t^{\alpha}\right]\right\} \tag{45}$$

Any equilibrium steady state, say $(k^*, c^*) \in (0,\infty)\times(0,\infty)$ must satisfy the conditions $\frac{k_{t+1}}{k_t} = \frac{c_{t+1}}{c_t} = 1$, $\forall t \in \mathrm{N}_+$. It follows from (44) that the locus $\frac{c_{t+1}}{c_t} = 1$ is given by the vertical line in Figure 6. Likewise, it follows from (45) that the locus $\frac{k_{t+1}}{k_t} = 1$ is given by the inverse U-shaped curve in Figure 6.

Figure 6: Steady state and transitional dynamics with fixed number of publicly provided intermediate goods, $\bar{N}$



[23] The two side conditions are: $k_0 \in (0,\infty)$, given and $[\beta(1+g_A)^{\gamma-1}]^t c_t^{\gamma} k_{t+1} \to 0$ as $t \to \infty$.

The intersection of these two lines (point A) defines the equilibrium steady state $\left(k^*, c^*\right) = \left(\left[\frac{\alpha(1-\hat{\psi}\bar{N})\xi(\bar{N})}{\beta^{-1}(1+g_A)-(1-\delta)} \right]^{\frac{1}{1-\alpha}}, c^* \right)$. It follows by inspection of the two difference equations (i.e., (44) and (45)) that the transitional dynamics around this steady state are as indicated by the directions of the arrows in Figure 6. Following standard arguments, it can be shown that there exists a unique stable local trajectory to the steady state (i.e., that satisfies the transversality condition, see Footnote 23), to which the economy converges, monotonically (See Figure 6). Given any initial value of k_0, consumption "jumps" to the value that corresponds to this stable local trajectory. Clearly, $\left(k^*, c^*\right)$ differs from the steady state of the Second Best (point B, say $\left(k^{SB}, c^{SB}\right)$), which lies to the north east of point A, by virtue of Proposition 3. And, for any given initial value of k_0, transitional dynamics (monotone convergence) will imply higher growth rates towards the steady state of the Second Best, versus that of point A.

Now, we are interested in the steady state and the transitional dynamics for different values of $\bar{N}$. Consider first an increase in the relative wage premium $\nu(.)$ that does not come from a change in $\bar{N}$. Clearly, in this case, following Proposition 2, $\xi(\bar{N})$ will decrease. The $\frac{k_{t+1}}{k_t}=1$ locus will drop and the $\frac{c_{t+1}}{c_t}=1$ locus will move left. The new steady state (illustrated by point C, in Figure 6) will lie to the south west of $\left(k^*, c^*\right)$. And, convergence to this steady state will imply slower growth. Finally, if $\bar{N}$ increases, both loci will move in the direction $(1-\hat{\psi}\bar{N})\xi(\bar{N})$ moves. Where the new steady state is going to be is now ambiguous and depends on the way $(1-\hat{\psi}\bar{N})\xi(\bar{N})$ alters with $\bar{N}$. As the following proposition makes clear, for $\bar{N}$ sufficiently high, $(1-\hat{\psi}\bar{N})\xi(\bar{N})$ will decrease with $\bar{N}$. But, for $\bar{N}$ sufficiently low the opposite might be true.

<u>Proposition 4</u>: *Given [R1] and [R2],* $\frac{d(1-\hat{\psi}\bar{N})\xi(\bar{N})}{d\bar{N}} < 0$ *for all* $\bar{N} \in \left[\frac{1-\alpha-b-\zeta}{1-\zeta}, \frac{1}{\hat{\psi}} \right)$*, such that:*

$$\bar{N} > \frac{1}{\hat{\psi}\left[1+\frac{\zeta}{(1-\zeta)(1-\alpha-b)}\right]}.$$

And, if:

$\frac{1-\alpha-b-\zeta}{1-\zeta} < \frac{1}{\hat{\psi}\left[1+\frac{\zeta}{(1-\zeta)(1-\alpha-b)}\right]}$, *there exists a sub-interval* $\left(\frac{1-\alpha-b-\zeta}{1-\zeta}, \bar{N}'\right)$ *of* $\left[\frac{1-\alpha-b-\zeta}{1-\zeta}, \frac{1}{\hat{\psi}\left[1+\frac{\zeta}{(1-\zeta)(1-\alpha-b)}\right]}\right)$ *such that* $\frac{d(1-\hat{\psi}\bar{N})\xi(\bar{N})}{d\bar{N}} > 0$, *for all* $\bar{N}$ *in this sub-interval.*

Proof: In the Appendix.

Proposition 4 can be, also, illustrated in Figure 6. In this case, an increase in $\bar{N}$ that decreases (increases) $(1-\hat{\psi}\bar{N})\xi(\bar{N})$ corresponds to a movement northeast (southwest) of point A, like point C (B). Hence, in the case of a fixed number of publicly provided intermediate goods, an increase in the number of these goods will have ambiguous effects on steady state output and growth towards this steady state, as these effects will depend on the existing number of publicly provided intermediate goods. However, the rationale for this nonlinearity is straightforward. For a relatively low *N*, an increase in this number is associated with the dominance of the "variety" effect over the combination of the "labor misallocation" and "tax distortion" effects. On the contrary, for a relatively high *N*, an increase in this number is associated with the dominance of the combination of the "labor misallocation" and "tax distortion" effects over the "variety" effect. For, as it can be easily verified, the "variety" effect ("labor misallocation" and "tax distortion" effects) is decreasing (are increasing) with *N*. The important implication of this result for the stylized facts of the Introduction, will be discussed in the next and last section.

3.4 The Steady State and Comparative Dynamics with Variable Number of Publicly Provided Intermediate Goods

First, observe that in the case of a variable number of publicly provided intermediate goods, in general, it is no longer possible to characterize the steady state and the transitional dynamics via a phase diagram, as the steady state and the transitional dynamics are characterized by three difference equations in three state variables. An exception, however, can be found in the special case of the Solow version. For, in this case, both the steady state and the transitional dynamics can be characterized in terms of two state variables. That is, k_t and N_t. To see this, suppose that $\gamma = \delta = 1$ and consider the claim that in this case, there exists an $s \in (0,1)$ such that

$i_t = s(1-\tau_t)y_t, \forall t \in \mathbb{N}_+$.[24] Following our new assumption and this claim, the transitional dynamics of the equilibrium are characterized by the three difference equations that follow[25]:

$$\frac{N_{t+1}}{N_t} = 1 + (\tilde{\psi} N_t)^{-1}\left(\tau_t - \hat{\psi} N_t\right) \tag{46}$$

$$\frac{c_{t+1}}{c_t} = a\beta(1+g_A)^{-1}(1-\tau_{t+1})\xi(N_{t+1})k_{t+1}^{\alpha-1} \tag{47}$$

$$\frac{k_{t+2}}{k_{t+1}} = \frac{y_{t+1}}{y_t} = \frac{c_{t+1}}{c_t} = \frac{i_{t+1}}{i_t} = \frac{s(1-\tau_{t+1})}{(1+g_A)}\xi(N_{t+1})k_{t+1}^{\alpha-1} \tag{48}$$

But, from the last two equations, we verify the claim that $s = a\beta \in (0,1)$.

Hence, we may rewrite (47) as

$$\frac{k_{t+1}}{k_t} = \frac{a\beta(1-\tau)}{(1+g_A)}\xi(N_t)k_t^{\alpha-1} \tag{49}$$

Now, before turning into the growth properties of this economy (i.e., in the case of an endogenous number of publicly provided intermediate goods), it will be convenient to examine first the case with an exogenously fixed income tax rate, $\tau_t = \tau \in (0,1)$, and a variable number of publicly provided intermediate goods. Clearly, in this case, (46) and (49) fully characterize the steady state and the dynamics of the equilibrium. The equilibrium steady state, say, $\left(k^*, N^*\right) \in (0,\infty)\times(0,\infty)$ must satisfy the conditions $\frac{k_{t+1}}{k_t} = \frac{N_{t+1}}{N_t} = 1, \forall t \in \mathbb{N}_+$. It follows from (46) that the locus $\frac{N_{t+1}}{N_t} = 1$ in the (k_t, N_t) space is given by the horizontal line intersecting the N_t axis at $\frac{\tau}{\hat{\psi}}$, in Figure 7. Likewise, it follows from (49) that the locus $\frac{k_{t+1}}{k_t} = 1$ in the (k_t, N_t) space is given by the rising and strictly concave curve in Figure 7. The intersection of these two lines at A defines the equilibrium steady state $\left(k^*, N^*\right)$, where $k^* = \left[\frac{\alpha\beta(1-\tau)\xi(\frac{\tau}{\hat{\psi}})}{1+g_A}\right]^{\frac{1}{1-\alpha}}$ and $N^* = \frac{\tau}{\hat{\psi}}$. In addition, following standard arguments, the curvature properties of these lines establish the existence and uniqueness of the equilibrium steady state.

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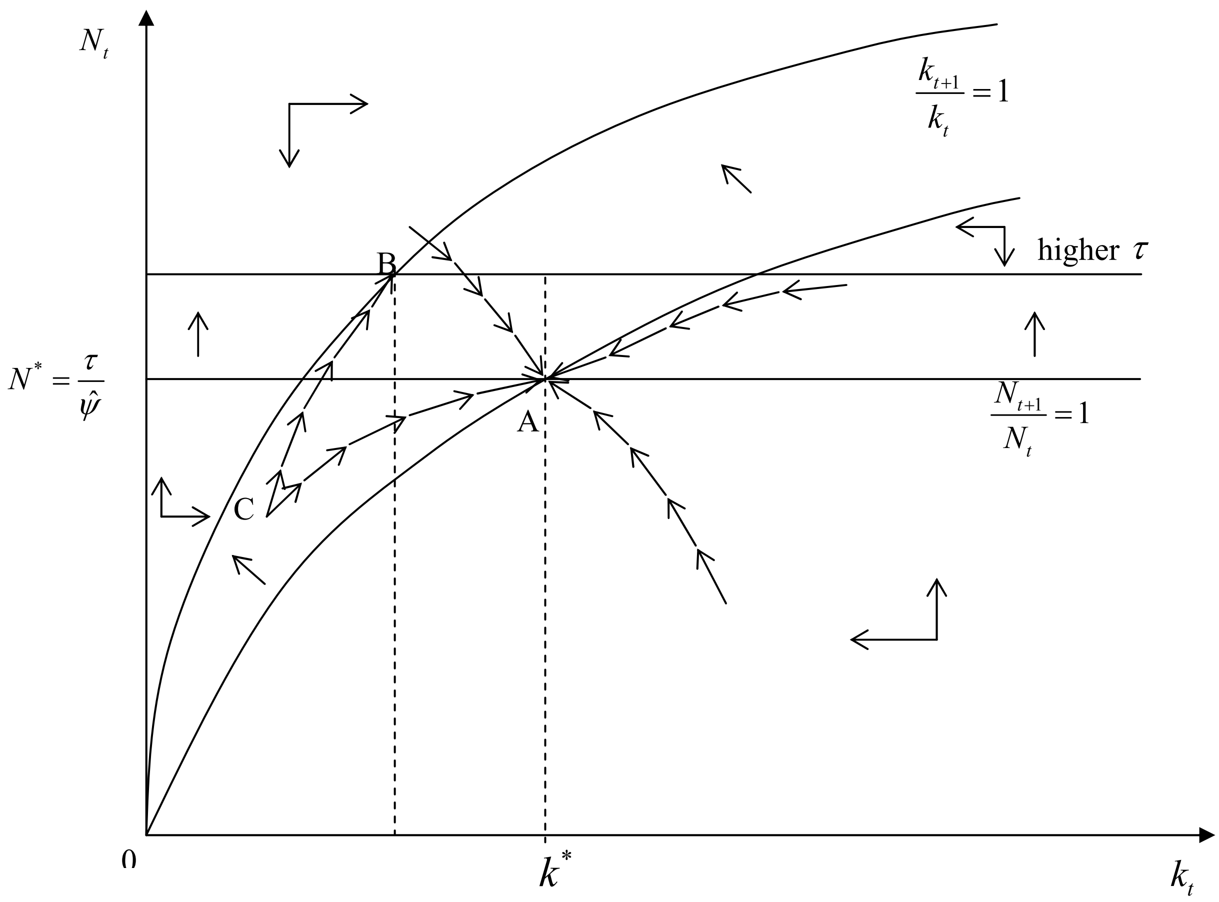
[24] $\gamma = 1$ implies logarithmic temporal utility function for the household and $\delta = 1$ implies full capital depreciation.

[25] Since, $(1+g_A)k_{t+1} = s(1-\tau)y_t$ and $y_t = c_t + i_t + \tilde{\psi}(N_{t+1} - N_t)y_t + \hat{\psi}N_t y_t = c_t + s(1-\tau)y_t + \tau y_t$, it follows that $c_t = (1-s)(1-\tau)y_t$. Using this, the second equality in (48) follows.

Figure 7: Transitional dynamics with variable number of intermediate goods, N_t



The transitional dynamics around the steady state are indicated by the direction of the arrows in Figure 7. That is, the local trajectories form a stable focus (See, e.g., the path converging from C to A, in Figure 7). It follows from the preceding analysis that:

Remark 6: In the Solow version, given [R1] and [R2], an increase in the income tax rate, τ , implies a new steady state with higher *N* and lower *k*. Moreover, convergence to this new steady state capital level, from any given initial level of capital, will be slower.

So, a higher income tax rate τ will lead to a steady state north-west of A, like point B in Figure 7. And, if the economy was initially at C, it will now move towards B along the indicated local trajectory. Steady state output and growth towards this steady state will be lower than when the economy moved from C to A. This Remark has important implications for the implications of public finances on output and growth.[26]

[26] It can be easily verified that if interest rates on outstanding debt is an increasing function of debt to GDP ratio there will be a uniquely determined level for the steady state of this ratio. And, an increase in the number of publicly provided intermediate goods will lead to an increase in this debt ratio, as well as the income tax. The proportion of tax to debt financing will depend on the rate at which interest rates increase with the debt to GDP ratio.

3.5 Government of Insiders

The stage has, now, been set to investigate the case of an endogenous number of publicly provided intermediate goods, N_t. In the equilibrium considered in the previous subsection and, in particular, in the Nash equilibrium characterizing the outcome of the insiders' unions strategic interaction, it was assumed that each union takes the number of intermediate goods as given and beyond their control. However, all unions have an incentive to increase the number of publicly provided intermediate goods, as this would increase the demand for labor that each one of them faces. But, in order to control the number of publicly provided intermediate goods, it must be that they control/influence the government. Motivated by the paradigm of South European countries, where political parties and governments have been dominated by unions and especially those of the greater public sector, it is interesting to examine what would happen if insiders' unions were controlling/influencing the government. Following Acemoglu (2009, Ch. 22), we may think of insiders' incentives to control/influence the government in terms of his: (a) "Revenue extraction", as the resources needed to maintain the old and finance the new infrastructures, underlying the provision of publicly provided intermediate goods; (b) "Factor price manipulation" as the lowering of prices of competing factors of production. That is, other than insiders' labor (see the demand for insiders' labor in Equation (13)); (c) "Political consolidation", as the need to control the government over time. This last one is not modeled here. But, it is, in a way, obvious, as the social planner to be introduced, has an infinite horizon utility function.

Thus, first we consider a situation where the government is fully controlled by insiders' unions. In this case, the objective function of the government is the sum of the insiders' unions utilities.[27] Once the objective function of the government is specified, the problem of the government is a straightforward social planner's problem. That is, the government decides on the income tax rate and the number of intermediate goods, so as to maximize its objective function, subject to the equilibrium laws of motion of the previous section and the government budget constraint.

There is no contradiction here with the fact that unions "play" non-cooperatively with respect to the wage rate and "play" cooperatively with respect to the income tax rate / the number of publicly provided intermediate goods. For, in the former game, an increase in the wage rate set by each union affects positively its own utility but negatively each other union, since it lowers total employment of all other unions and hence exercises a negative influence on its own wage rate. However, a higher, say, income tax rate, increases the number of publicly provided intermediate

[27] This is what is referred to as "political elite" (see e.g., Acemoglu 2009, ch. 22). Elites are taken to make the political decisions and possibly engage in economic activities. In our case, the political elite consists of the members of insiders' unions. Or, again, in Acemoglu's terminology, we assume insiders' unions to enjoy de facto political power.

goods, and increases the demand for labor facing each union, due to gross complementarity. Hence, all insiders' unions have an incentive to increase this tax rate (financing of the underlying infrastructure). For that matter, unions' interests are simultaneously to compete for wage premiums and cooperate for the number of publicly provided intermediate goods. On the contrary, however, in a world of no insiders, such a complementarity does not exist. And, following standard arguments, both households and politicians set the income tax rate / number of publicly provided intermediate goods, so as to maximize the utility of the Median Voter. Thus, we are interested in comparing the income tax rate / number of intermediate goods chosen by the "Government of Insiders" social planner, versus the Median Voter social planner.

In either case, the government budget constraint, is such that choosing the number of intermediate goods in the beginning of period *t+1* completely determines the income tax rate. Hence, it is assumed that there is a commitment technology vis-à-vis the income tax rate.[28] To continue, let the objective function of the Government of Insiders be the sum of utilities of all insiders' unions[29]:

$$\sum_{t=0}^{\infty}\beta^t\int_0^{N_t}\left[w_t^i(z)-w_t^0\right]^{\lambda(z)}L_t^i(z)dz$$

which, in the symmetric case, reduces to:

$$\sum_{t=0}^{\infty}\beta^t\left(w_t^i-w_t^0\right)^{\lambda}N_tL_t^i$$

Using the equilibrium conditions (16), (22), (32), (33), (39) and (40), the above objective function can be written as:

$$\sum_{t=0}^{\infty}\beta^t\upsilon(N_t)^{\lambda}\xi(N_t)^{\lambda}k_t^{a\lambda} \tag{50}$$

where

$$\upsilon(N_t)=\frac{1-\dfrac{1}{\nu(N_t)}}{\left[1-a-b+b\nu(N_t)\right]^{(1-\lambda)/\lambda}} \tag{51}$$

Thus, in the symmetric case and in the Solow specification, the problem of the Government of Insiders social planner is to find a plan of the form $\{k_{t+1},N_{t+1}\}_{t=0}^{\infty}$ so as to maximize (50), subject to:

$$(1+g_A)k_{t+1}=a\beta\left[1-\tilde{\psi}(N_{t+1}-N_t)y_t-\hat{\psi}N_t\right]\xi(N_t)k_t^a \tag{52}$$

and the initial condition $(k_0,N_0)\in\mathbb{R}_+\times\mathbb{R}_+$, given.

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[28] Admittedly, here we avoid all problems that arise due to the possibility of no such commitment. See, e.g., Acemoglu (2009, Ch. 22), for what he refers to as the "hold up" problem.

[29] Kollintzas et al. (2012) consider additional groups, not related to public sector unions, as being part of the coalition of the Government of Insiders, such as entrepreneurs engaging in public procurement and self employed organized in closed professions.

Likewise, the problem of the Median Voter social planner can be stated as the problem of the Government of Insiders, but instead of (50) the objective function is given by:[30]

$$\sum_{t=0}^{\infty}\beta^t \ln c_t = \sum_{t=0}^{\infty}\beta^t \ln\left\{(1-a\beta)\left[1-\tilde{\psi}(N_{t+1}-N_t)y_t-\hat{\psi}N_t\right]\xi(N_t)k_t^a\right\} \tag{53}$$

Then, the following, establishes the main result of the paper.

<u>Proposition 5</u>: *Given [R1], [R2],*

[R3] $$\frac{(1-a-b)(1-\zeta)\left[1-\hat{\psi}(1-a-b-\zeta)\right]}{(1-a-b-\zeta)\zeta} > \left(\beta^{-1}-1\right)\tilde{\psi}+\hat{\psi}$$

and

[R4] $\lambda\in\left[1/2,1\right)$ or $\lambda\in\left(0,1/2\right]$ and $\dfrac{-b(2\lambda-1)}{1-\lambda(1-\zeta)+\lambda\hat{\psi}(1-a-b-\zeta)} < \lambda\left[2(1-a-b)(1-\lambda)+b\right]$

there exist unique steady states associated with the Median Voter social planner problem and "Government of Insiders" problem, $\left(k^{MV},N^{MV}\right)$, $\left(k^{GI},N^{GI}\right)$*, respectively, such that:*

$$\begin{aligned}
&(1-\hat{\psi}N^{MV})\frac{\xi'(N^{MV})}{\xi(N^{MV})}\\
&=(\beta^{-1}-1)\tilde{\psi}+\hat{\psi}\\
&=(1-\hat{\psi}N^{GI})\frac{\xi'(N^{GI})}{\xi(N^{GI})}+\frac{(1-a\beta)}{a\beta}(1-\hat{\psi}N^{GI})\left[\frac{\xi'(N^{GI})}{\xi(N^{GI})}+\frac{\upsilon'(N^{GI})}{\upsilon(N^{GI})}\right]
\end{aligned} \tag{54}$$

Moreover, $N^{GI} > N^{MV}$ *and*

$$k^i = \left[\frac{a\beta(1-\hat{\psi}N^i)\xi(N^i)}{1+g_A}\right]^{\frac{1}{1-a}},\ i=MV,\ GI. \tag{55}$$

<u>Proof</u>: In the Appendix.

Condition (54) is the key condition for establishing the existence and uniqueness results, as well as the ordering between N^{GI} and N^{MV}. To understand the meaning of this condition, consider the costs and benefits, to the Median Voter Social Planner, associated with an increase in the number of publicly provided intermediate goods, where these costs and benefits are measured in terms of appropriately discounted utility increases associated with increases in consumption of an equal amount as the amount of resources associated with these costs and benefits.[31] First, an

[30] This is the utility of the representative household, when $\gamma=1$. See Footnote 23.

[31] Using the fact that $c=(1-a\beta)(1-\hat{\psi}N)\xi(N)k^a$, these discounted utilities can be written as follows: $\sum_{t=0}^{\infty}\beta^t\ln\left[(1-a\beta)(1-\hat{\psi}N)\xi(N)k^a\right]$ and $\sum_{t=0}^{\infty}\beta^t\left[\frac{\upsilon(N)}{(1-a\beta)(1-\hat{\psi}N)}\right]^{\lambda}\ln\left[(1-a\beta)(1-\hat{\psi}N)\xi(N)k^a\right]^{\lambda}$ in the Median Voter and Government of Insiders social planner problems, respectively.

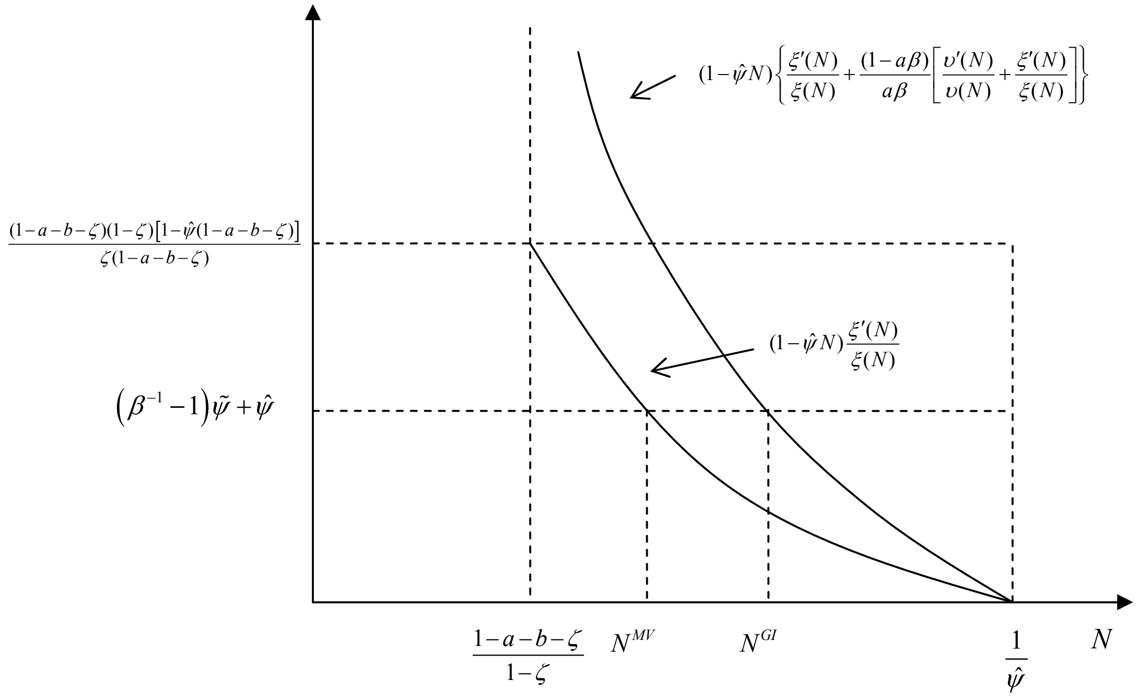
increase in the number of publicly provided intermediate goods will result in a decrease in the amount of (efficient) private capital available at the beginning of next period equal to $\tilde{\psi} a\beta\xi(N)k^{a}$, due to the diversion of resources from private capital investment to the construction of the underlying infrastructure associated with the publicly provided intermediate goods. Second, there will be a decrease in the amount of capital available at the end of next period equal to $\hat{\psi} a\beta\xi(N)k^{a}$, due to the diversion of resources from private capital investment to the maintenance of this infrastructure. And, third, there will be an increase in the amount of private capital available at the end of next period, $\tilde{\psi} a\beta\xi(N)k^{a}$, due to the ensuing non-diversion of resources to the construction of this infrastructure, since it is already in place. On the other hand, the benefits associated with an increase in the number of publicly provided intermediate goods are due to the increase in consumption brought about, in the next period, by the ensuing increase in TFP, $(1-a\beta)(1-\hat{\psi}N)\frac{\xi'(N)}{\xi(N)}\xi(N)k^{a}$. And, in addition, in the case of the "Government of Insiders", the benefits, in the next period, associated with the increase in the wage premium, that is not embodied in the TFP, $\frac{(1-a\beta)(1-\hat{\psi}N)\xi(N)k^{a}}{(1-a\beta)(1-\tilde{\psi}N)}\frac{\upsilon'(N)}{\upsilon(N)}$.[32] Hence, (54) requires that these costs and benefits, appropriately discounted, must be equal at the margin. Now, the stage has been set to look into the restrictions of Proposition 6.

Restrictions [R3], [R4] and the comparison between the steady states of the Median Voter and Government of Insiders problems, are illustrated in Figure 8. Proposition 2 ensures that $\frac{\xi'(N)}{\xi(N)}$ is strictly positive. Likewise, it is shown that, given [R1] and [R2], $\frac{\upsilon'(N)}{\upsilon(N)}$ is strictly positive. Moreover, it is shown that $\frac{\upsilon'(N)}{\upsilon(N)}$ approaches $+\infty$ as N approaches $\frac{1-a-b-\zeta}{1-\zeta}$ *(i.e.,* $v(N)$ approaches 1) and approaches 0 as N approaches $\frac{1}{\hat{\psi}}$ (i.e., the endpoint of its range). Further, it is shown that both $(1-\hat{\psi}N)\frac{\xi'(N)}{\xi(N)}$ and, given [R4], $(1-\hat{\psi}N)\frac{\upsilon'(N)}{\upsilon(N)}$ are strictly decreasing in N. Finally, [R3] ensures that $(1-\hat{\psi}N)\frac{\xi'(N)}{\xi(N)}$ intersects the $(\beta^{-1}-1)\tilde{\psi}+\hat{\psi}$ locus in $\left(\frac{1-a-b-\zeta}{1-\zeta}, \frac{1}{\hat{\psi}}\right)$.

[32] To see this, note that the slope of the indifference curves of the insiders' unions in the *(c, N)* space is given by $-\frac{dc}{dN}=\frac{c}{(1-a\beta)(1-\tilde{\psi}N)}\frac{\upsilon'(N)}{\upsilon(N)}$.

Clearly, [R3] is not really restrictive, if one is interested in an interior steady state. [R4] is much less obvious.

Figure 8. Illustration of existence of a unique steady state in the Median Voter and Government of Insiders problems



First, note that if [R4] does not hold, one cannot rule out the possibility of an upward sloping $(1-\hat{\psi}N)\left\{\frac{(1-a\beta)}{a\beta}\frac{\upsilon'(N)}{\upsilon(N)}+\frac{1}{a\beta}\frac{\xi'(N)}{\xi(N)}\right\}$ locus. In this case, of course, an interior equilibrium may not exist or there might be multiple equilibria. In particular, [R4] may not hold if the weight insiders' unions put on the wage premium, relative to the weight they put on employment, is sufficiently low. Now, with λ low, the $(1-\hat{\psi}N)\frac{(1-a\beta)}{a\beta}\frac{\upsilon'(N)}{\upsilon(N)}$ locus will be upward sloping. Moreover, the wage premium in the public sector will tend to be small and therefore the misallocation effect will be, likewise, relatively small. Then, it might be more likely, in the case of relatively small *N*, for the combined tax distortion and labor misallocation effects to dominate over the variety effect by a small amount, so that the $(1-\hat{\psi}N)\left\{\frac{(1-a\beta)}{a\beta}\frac{\upsilon'(N)}{\upsilon(N)}+\frac{1}{a\beta}\frac{\xi'(N)}{\xi(N)}\right\}$ locus ends up being upward sloping. In this case, we may have one equilibrium with low N and τ, and one equilibrium with high N and τ. Clearly, then, [R4] produces multiple equilibria in the Government of Insiders solution.[33]

[33] More on this on the last section.

The ordering between N^{GI} and N^{MV} is a manifestation of the "political effect" mentioned in the introduction. Recall that the Median Voter solution incorporates the "labor misallocation" effect. So, steady state capital per efficient household in the Median Voter solution is already lower than the Second Best (i.e., the no wage premium but with distorting taxation social planner's solution).[34] Thus, while the Median Voter social planner chooses the number of publicly provided intermediate goods balancing (at the margin) the "variety" effect with the combination of the "labor misallocation" and the "tax distortion" effects, the Government of Insiders chooses that number so as to balance the combination of the "variety" effect and the utility gains from the public sector wage premium (i.e., the "political" effect) with the combination of the "labor misallocation" and "tax distortion" effects. For that matter, the Government of Insiders chooses a greater number of intermediate goods than the Median Voter social planner. Note, however, that combining Propositions 4 and 6, there is no direct answer to the question whether there will be a higher or a lower steady state capital in the Median Voter social planner solution or the Government of Insiders solution. In particular, for relatively low numbers of steady state publicly provided intermediate goods, $\left(N^{MV}, N^{GI}\right)$, a higher number of those goods may entail higher steady state output and faster growth (i.e., growth along the convergence to the steady state). But, for a relatively higher number of steady state publicly provided intermediate goods (N^{MV}, N^{GI}) a higher number for these goods leads to lower steady state output and growth. In that sense, it is more likely of the solution of the Government of Insiders to lead to lower steady state output and growth than in the Median Voter solution. We summarize this important result in the following remark.

Remark 7: Let $\left(k^{MV}, N^{MV}\right)$ and $\left(k^{GI}, N^{GI}\right)$ be as in Proposition 5. If $N^{MV}, N^{GI} \in \mathcal{N}_2 = \left(\underline{N}_2, \bar{N}_2\right) = \left[\frac{(1-a-b)(1-\zeta)}{\hat{\psi}\left[(1-a-b)(1-\zeta)+\zeta\right]}, \frac{1}{\hat{\psi}}\right)$ then $k^{MV} > k^{GI}$. And, if $N^{MV}, N^{GI} \in \mathcal{N}_4 = \left(\underline{N}_4, \bar{N}_4\right) \subset \mathcal{N}_3 = \left[\underline{N}_3, \bar{N}_3\right) = \left[\frac{(1-a-b-\zeta)}{(1-\zeta)}, \frac{(1-a-b)(1-\zeta)}{\hat{\psi}\left[(1-a-b)(1-\zeta)+\zeta\right]}\right)$ such that $\frac{d(1-\hat{\psi}N)\xi(N)}{dN} > 0, \forall N \in \mathcal{N}_4$, then $k^{MV} < k^{GI}$.

Unfortunately, no clear cut answer can be obtained if N^{GI} is in the sub-interval of relatively large N and N^{MV} is in the sub-interval of relatively low N.

These comparisons are motivated by economies with different structures. In fact, for the case of a single economy, we may get a somewhat "cleaner" answer on the growth question, if instead of

[34] In terms of Figure 8, the Second best corresponds to a solution with a $(1-\hat{\psi}N)\frac{\xi'(N)}{\xi(N)}$ locus that declines faster than the one depicted in this figure.

comparing the Median Voter solution to the Government of Insiders solution, we consider a hybrid of these solutions. That is, following the political economy literature (see, e.g., Persson and Tabellini (2002), Ch. 7) we consider a government that to some degree is influenced by Median Voter preferences and is influenced, likewise, by the Government of Insiders preferences. Thus, to avoid scale problems, we consider a government that seeks to minimize a weighted average of the percentage deviations of: (a) the welfare of the representative household from the welfare achieved under the solution of the Median Voter; and (b) the welfare of all insiders' unions from the welfare achieved under the solution of the Government of Insiders:

$$W^{\rho} = \frac{\rho\left\{\overline{W}^{MV} - W^{MV}\left[\left\{k_{t+1}, N_{t+1}\right\}_{t=0}^{\infty}; \left(k_0, N_0\right)\right]\right\}}{\overline{W}^{MV}} + \frac{(1-\rho)\left\{\overline{W}^{GI} - W^{GI}\left[\left\{k_{t+1}, N_{t+1}\right\}_{t=0}^{\infty}; \left(k_0, N_0\right)\right]\right\}}{\overline{W}^{GI}} \quad (56)$$

subject to the effective capital law of motion (52) and the initial condition, where $1-\rho \in (0,1)$ is the relative influence of insiders' unions on the government. Then, following the proof of Proposition 5, it can be readily established that:[35]

<u>**Proposition 6**</u>***:*** *Given [R1], [R2] and [R3], there exists a unique steady state* $\left(k^{\rho}, N^{\rho}\right)$ *associated with the problem of a government that seeks to minimize* W^{ρ}*, subject to (52) and the initial condition. Then, an increase in the relative influence of insiders' unions,* $1-\rho$*, would lead to higher steady state value of* N^{ρ}.

In particular, this proposition is useful for it is helpful in explaining the stylized facts of the Introduction. For, if countries differ with respect to $1-\rho$ (i.e., the relative weight of insiders in influencing the government), countries with high $1-\rho$ will eventually have a high number of publicly provided intermediate goods and these countries will be more likely to have a number of publicly provided intermediate goods which is higher than the threshold of Proposition 4. Then, these countries will have lower steady state capital, output and growth than countries with relatively low $1-\rho$. For example, one may think of the South European countries having very high $1-\rho$, so that the lower bound of N in Proposition 4 is exceeded and the countries with very low or non-existent public sector wage premia in Figure 1, as, for example, the Anglo-Saxon countries (except Australia), having very low $1-\rho$, so that steady state N is below the above threshold.

In addition, it can explain the increase in the wage premium in the public sector of the Southern European countries, over the last forty years to their growth experience. In the model's framework, one may think of South European countries, as countries with high $1-\rho$ (insiders'

[35] If ρ is allowed to take the value 0, [R4] is also needed.

influence over government) but with a low initial level of N. Thus, thirty to forty years ago, the advent of the insiders-outsiders society in Southern European countries, when these countries were at a lower stage of development and, to a varying degree, they were lacking adequate infrastructures, may have helped them develop and grow. Precisely because, it led to the development of that infrastructure, when private provision of this infrastructure was poor or non-existing. But, eventually, the insiders-outsiders society may have exceeded its usefulness and insiders' unions enjoyed substantial wage premia, leading to labor misallocation and tax distortion and/or high debt that caused the growth problems these countries are experiencing at the present.

4. STYLIZED FACTS EXPLANATIONS AND POSSIBLE EXTENSIONS

In this paper, we focused on the facts that: (a) There are significant differences in the wage premium in the public sector across developed economies. (b) The South European countries top the list as the countries with the highest wage premium in the public sector in a representative group of developed economies. (c) There is a significant variation in the wage premium in some countries over time. (d) The wage premium in the public sector correlates negatively with the ratio of employment in the public sector over total employment, across developed economies. (e) The wage premium in the public sector correlates negatively with the conditional growth rate in a representative panel of developed economies.

These facts do not seem to have received much attention in the empirical or theoretical labor economics and economic growth literatures. Thus, we developed a model, based on the South European economic and political paradigm of recent years, that provides for a unifying explanation for these facts.

The main idea is the modeling of insiders' unions. That is, powerful unions that set wages in the production of services associated with publicly provided intermediate goods, like basic networks and major utilities; and, that cooperate to control / influence the government in deciding for the creation / destruction and maintenance of these publicly provided intermediate goods, as seems to be the case in Southern European countries. This cooperation seeks to exploit an important complementarity in the provision of these intermediate goods that is to the interest of each individual union of insiders. The model explains the above stylized facts via differences in the efficacy of insiders' unions in establishing a wage premium in the public sector and their ability to influence government in providing a sufficiently high number of intermediate goods.

There are several possible extensions to this model. A straightforward extension is to generalize the intermediate good service producer – union of insiders strategic interaction using the Nash bargaining solution, popularized by Manning (1987). This way, it should be possible to extend the scope of the model by bringing into the picture the relative bargaining power of the union and examine its influence on the final politico-economic equilibrium. This is important because that way it should be possible to investigate the effect of cooperating and non-cooperating unions on the above mentioned solution. The model could be also extended to insiders' unions operating under uncertainty, using the Markov perfect equilibrium, as in Espinosa and Rhee (1989) and Eberwein and Kollintzas (1995).

One of the hardest choices we had to make in this model was between treating intermediate goods as exclusively publicly provided or allow for the possibility these goods to be either publicly or privately provided. We opted treating intermediate goods as exclusively publicly provided, for we thought more appropriate, in this first attempt to model the insiders-outsiders society, to keep things as simple as possible. Our choice, of course, has a cost, in that, in order to explain the stylized facts presented in the Introduction and especially the big differences in the wage premium in the public sector across countries and their implications for the corresponding economic growth paths, we had to nest the politico-economic systems of the underlying countries within the simple model. But, since differences in the technological parameters of this model are not so plausible across countries, we attributed the observed big differences in non-technological parameters. For example, we took South European countries as having high $1-\rho$ (i.e., degree of influence of insiders' unions over government) and high λ (i.e., relative importance of the wage premium over employment in union preferences). And, we took the opposite to be true for the countries with very low or non-existent wage premium in the public sector, like the Anglo-Saxon countries, except Australia. But, there are other profound reasons for these observed public sector wage premium differentials, that cannot be accounted by the "straightjacket" of one simple model. Strong unions may characterize the public as well as the private sector, as has been suggested for the Scandinavian countries and France (see, e.g., Blanchard (2004) and Sapir (2006)). This, in fact, could be important in explaining low public sector wage premia and relatively low growth in these countries. In general, the observed divergence in growth paths could be due to systematic technological differences among unionized and non-unionized sectors, across countries. In future work, we plan to correct these problems. A promising path is to use the idea of competing institutional frameworks, recently introduced by Acemoglu, et al. (2012). Allowing for monopolistically privately provided intermediate goods and corresponding insiders' unions that, as already mentioned, they either choose to cooperate or non-cooperate with the corresponding intermediate good producers. If entrepreneurs face unions that they choose to cooperate it would be easier for them to invest in new infrastructure (enter in the intermediate goods market) and thereby introduce new technology. Thereby, energizing a more powerful growth stimulating "variety" effect than the one considered here. The opposite will tend to be true if entrepreneurs face unions that do not cooperate and are, in general, fairly aggressive. This, then, presents social planners with an interesting trade-off: Choose low tax rates and make investment in new varieties of intermediate goods easier or high tax rates and public provision of new intermediate goods. Or, even provide subsidies that lower frictions in the adaptation of world technology (i.e., á-la Parente and Prescott(1994)). It seems that this trade-off may lead to different social planner solutions even in the case of identical Median Voter social planners.

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APPENDIX

Proof of Proposition 2

By definition,

$$\xi(N) = b^b(1-a-b)^{1-a-b}\Phi^{1-a-b}N^{\frac{(1-a-b)(1-\zeta)}{\zeta}}\frac{v(N_t)^b}{\left[1-a-b+bv(N)\right]^{1-a}}$$

Since [R2] implies [R2'], given [R1] and [R2], $v(N)>1$, $\forall N \in \left(\frac{1-\alpha-b-\zeta}{1-\zeta},\infty\right)$. Therefore, $\xi(N)>0$, $\forall N \in \left(\frac{1-\alpha-b-\zeta}{1-\zeta},\infty\right)$.

To show (a), fix $N=\bar{N} \in \left(\frac{1-\alpha-b-\zeta}{1-\zeta},\infty\right)$ and consider ξ as a function of $\bar{v}=v(\bar{N})>1$. That is, let:

$$\xi(\bar{N}) = \xi\left[v^{-1}(\bar{N})\right] \equiv \bar{\xi}(\bar{v}) \equiv b^b(1-a-b)^{1-a-b}\Phi^{1-a-b}\bar{N}^{\frac{(1-a-b)(1-\zeta)}{\zeta}}\frac{\bar{v}^b}{\left[1-a-b+b\bar{v}\right]^{1-a}}$$

And, therefore,

$$\left.\frac{\partial\xi}{\partial v}\right|_{N=\bar{N}} = \bar{\xi}'(\bar{v}) = b^b(1-a-b)^{1-a-b}\Phi^{1-a-b}\bar{N}^{\frac{(1-a-b)(1-\zeta)}{\zeta}}\frac{(1-a-b)b\bar{v}^{b-1}(1-\bar{v})}{\left[1-a-b+b\bar{v}\right]^{2(1-a)}}<0,$$

given [R1] and [R2].

To show (b), differentiate $\xi(N)$ with respect to N, to get:

$$\xi'(\mathrm{N}) = \xi(\mathrm{N})\frac{1-a-b}{N}\left\{\frac{1-\zeta}{\zeta}-\frac{bv'(N)N[v(N)-1]}{v(N)\left[1-a-b+bv(N_t)\right]}\right\}$$

And, since by (32) $v'(N)=\frac{\lambda(1-a-b-\zeta)v(N)^2}{N^2}$

$$\xi'(N) = \xi(N)\frac{1-a-b}{N}\left\{\frac{1-\zeta}{\zeta}-\frac{\lambda b(1-a-b-\zeta)v(N)[v(N)-1]}{N\left[1-a-b+bv(N_t)\right]}\right\} \tag{A.1}$$

Clearly, then, given [R1] and [R2],

$\xi'(N) \overset{>}{\underset{<}{=}} 0$ as $\frac{1-\zeta}{\zeta}-\frac{\lambda b(1-a-b-\zeta)v(N)[v(N)-1]}{N\left[1-a-b+bv(N_t)\right]} \overset{>}{\underset{<}{=}} 0$ or as $\wp(N) \overset{<}{\underset{>}{=}} 0$, where:

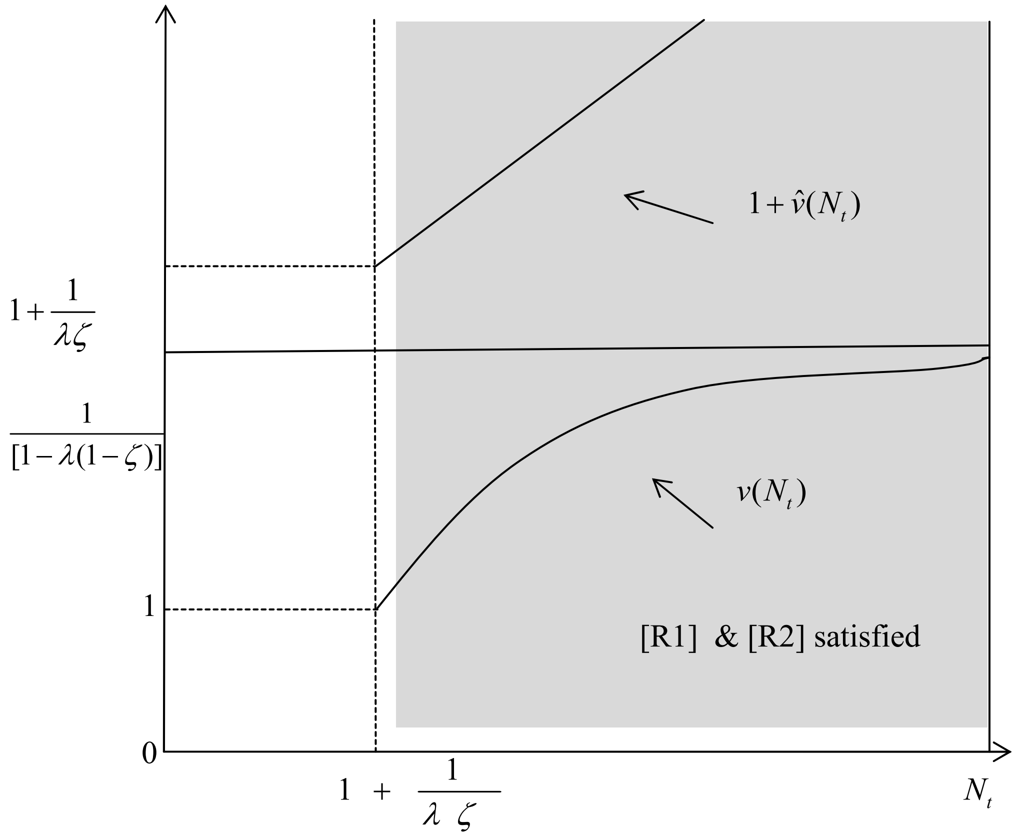
$$\wp(N) \equiv v(N)^2-[1+\hat{v}(N)]v(N)-\frac{1-a-b}{b}\hat{v}(N),$$

and $\hat{v}(N) \equiv \frac{(1-\zeta)N}{\lambda\zeta(1-a-b-\zeta)}>0$

But, given [R1] and [R2] $[1+\hat{v}(N)] > v(N)$, $\forall N \in \left(\frac{1-\alpha-b-\zeta}{1-\zeta}, \infty\right)$. To see this, note that $v(N)=1$ for $N=\frac{1-\alpha-b-\zeta}{1-\zeta}$. And, given [R1] and [R2] it is strictly increasing (i.e., $v'(N)>0$), strictly concave (i.e., $v''(N)<0$), and approaches asymptotically $\frac{1}{1-\lambda(1-\zeta)}>1$ as $N \to \infty$. On the other hand, $[1+\hat{v}(N)]$ is $1+\frac{1}{\lambda\zeta} > \frac{1}{1-\lambda(1-\zeta)}$ for $N=\frac{1-\alpha-b-\zeta}{1-\zeta}$ and increases at a constant rate, throughout $\left(\frac{1-\alpha-b-\zeta}{1-\zeta}, \infty\right)$. (Figure A illustrates these facts). Therefore, given [R1] and [R2], $\wp(N)<0$, $\forall N \in \left(\frac{1-\alpha-b-\zeta}{1-\zeta}, \infty\right)$ and hence $\xi'(N)>0$, $\forall N \in \left(\frac{1-\alpha-b-\zeta}{1-\zeta}, \infty\right)$.

Q.E.D.

Figure A



Proof of Proposition 3

It follows from (43) that $\pi(N_t) \overset{>}{\underset{<}{=}} 0$ as $1 \overset{>}{\underset{<}{=}} \frac{v(N_t)^b}{\left\{1+\frac{b}{1-a}[v(N_t)-1]\right\}^{1-a}}$. Or, given [R1] and [R2],

$\pi(N_t) \overset{>}{\underset{<}{=}} 0$ as

$$1+\frac{b}{1-a}[v(N_t)-1] \overset{>}{\underset{<}{=}} v(N_t)^{b/(1-a)} \tag{P3.1}$$

Observe, that the LHS of the last inequality is a linear function, with value $(1-a-b)/(1-a)$ when $v=0$ and with value 1 when $v=1$. Since, by assumption, $0<b,\ 0<(1-a-b)$, $[b/(1-a)]<1$. Therefore, the RHS of the last inequality is a strictly increasing and strictly concave function with value 0, when $v=0$ and with value 1, when $v=1$.It follows that the LHS of (P3.1) is greater than the RHS of (P3.1), for all $v>1$. But, given [R1] and [R2], $v>1$. Hence $\pi(N_t)>0$ for all N_t.

The signs of the two derivatives can be easily obtained by a similar argument like the one used for the characterization of the sign of $\pi(N_t)$.

Proof of Proposition 4

Note that:

$$\frac{d(1-\hat{\psi}N)\xi(N)}{dN} \overset{>}{\underset{<}{=}} 0 \text{ as } \frac{\xi'(N)\xi(N)}{\xi(N)} \overset{>}{\underset{<}{=}} \frac{\hat{\psi}N}{1-\hat{\psi}N} \tag{A.2}$$

Therefore, in view of (A.1), (A.2) yields:

$$\frac{d(1-\hat{\psi}N)\xi(N)}{dN} \overset{>}{\underset{<}{=}} 0 \text{ as } \Re\left[v(N),N\right] \overset{<}{\underset{>}{=}} 0$$

where

$$\Re\left[v(N),N\right] \equiv v(N)^2-\left[1+\tilde{v}(N)\right]v(N)-\frac{1-a-b}{b}\tilde{v}(N)$$

and

$$\tilde{v}(N) \equiv \left[\frac{1-\zeta}{\zeta}-\frac{\hat{\psi}N}{(1-a-b)(1-\hat{\psi}N)}\right]\frac{\hat{\psi}N}{\lambda\hat{\psi}(1-a-b-\zeta)}$$

Given [R1] and [R2], $0<\frac{1-\alpha-b-\zeta}{1-\zeta}<1$ and in view of the facts that $\tau=\hat{\psi}N$ and $0<\tau\le 1$, N is restricted to be in the interval

$\mathcal{N}_1 \equiv \left(\underline{N}_1,\overline{N}_1\right) \equiv \left[\frac{1-\alpha-b-\zeta}{1-\zeta},\frac{1}{\hat{\psi}}\right)$. Note, then, that if $N \in \mathcal{N}_2 \equiv \left[\underline{N}_2,\overline{N}_2\right) \equiv \left[\frac{(1-a-b)(1-\zeta)}{\hat{\psi}\left[(1-a-b)(1-\zeta)+\zeta\right]},\frac{1}{\hat{\psi}}\right)$, $\tilde{v}(N)\le 0$. And, since [R1] and [R2] imply that $v(N)\ge 1, \forall N \in \mathcal{N}_1$, it follows that $\Re\left[v(N),N\right]>0$,

$\forall N \in \mathcal{N}_1 \cap \mathcal{N}_2 = \left[\max\{\underline{N}_1, \underline{N}_2\}, \bar{N}_2\right)$. Hence, $\frac{d(1-\hat{\psi}N)\xi(N)}{dN} < 0$, $\forall N \in \mathcal{N}_1 \cap \mathcal{N}_2$. Further, observe that if $\underline{N}_2 \leq \underline{N}_1$, $\mathcal{N}_1 \cap \mathcal{N}_2 = \mathcal{N}_1$ and there is no other case left to consider. Thus, suppose that $\underline{N}_2 > \underline{N}_1$ and consider the case where $N \in \mathcal{N}_3 \equiv \left(\underline{N}_3, \bar{N}_3\right) = \left(\underline{N}_1, \underline{N}_2\right)$. Clearly, in this case $\tilde{v}(N) > 0$, $\forall N \in \mathcal{N}_3$. It follows that $\Re\left[v(N), N\right]$ may be factored as follows:

$\Re\left[v(N), N\right] = \left[v(N) - \bar{v}(N)\right]\left[v(N) - \underline{v}(N)\right]$

where $\underline{v}(N)$, $\bar{v}(N) : \mathcal{N}_3 \to \mathbb{R}$, such that:

$-\underline{v}(N)$, $\bar{v}(N) > 0$

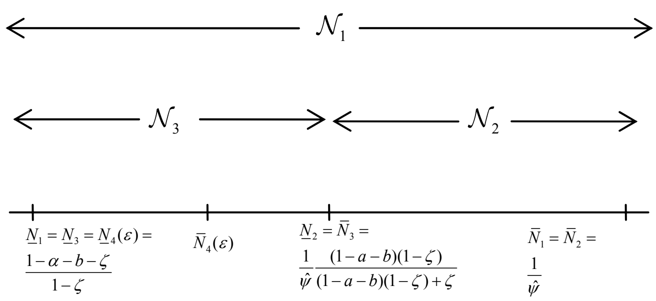
$\underline{v}(N)\bar{v}(N) = \frac{1-\alpha-b}{b}\tilde{v}(N) < 0$

Therefore, $\Re\left[v(N), N\right] < 0$, for all $N \in \mathcal{N}_3$, if and only if $1 \leq v(N) < \tilde{v}(N)$, for all $N \in \mathcal{N}_3$.

In this case, of course, $\frac{d(1-\hat{\psi}N)\xi(N)}{dN} > 0$, $\forall N \in \mathcal{N}_3$. To complete the proof, it suffices to show that there exists a non-empty sub-interval of $\mathcal{N}_3$ such that $1 \leq v(N) < \bar{v}(N)$. To show this, first observe that $1 \leq v(N) < \bar{v}(N)$, $\forall N \in \mathcal{N}_3$, if and only if $1 \leq v(N) < 1 + \tilde{v}(N) + \varepsilon$, $\forall N \in \mathcal{N}_3$, where $0 < \varepsilon < \sup\left[-\underline{v}(N)\right]$. Recall that $v(N) : \mathcal{N}_1 \to \left[1, v(\bar{N}_1)\right]$ is strictly increasing throughout its domain and $v(\underline{N}_1) = v(\underline{N}_3) = 1$. Consider, now, any sufficiently small $\varepsilon \in \left(0, \sup_{N \in \mathcal{N}_3}\left[-\underline{v}(N)\right]\right)$, and observe that there exists $\bar{N}_4(\varepsilon) \in \mathcal{N}_3$ and $\bar{N}_4(\varepsilon) > \underline{N}_3$ such that $v\left(\bar{N}_4(\varepsilon)\right) = 1 + \varepsilon$. Clearly, then, $1 \leq v(N) < 1 + \tilde{v}(N) + \varepsilon$ for all $N \in \mathcal{N}_4(\varepsilon) \equiv \left(\underline{N}_4(\varepsilon), \bar{N}_4(\varepsilon)\right) = \left(\underline{N}_3, v^{-1}(1+\varepsilon)\right) \subset \mathcal{N}_3$ (See Figure B, for an illustration).

Q.E.D.

Figure B: An illustration of the sub-interval of $\mathcal{N}_1$, where $\frac{d(1-\hat{\psi}N)\xi(N)}{dN} < 0$, $\mathcal{N}_2$, and the sub-interval of $\mathcal{N}_1$, where $\frac{d(1-\hat{\psi}N)\xi(N)}{dN} > 0$, $\mathcal{N}_4(\varepsilon)$.



Proof of Proposition 5

The social planner's objective function in the Government of Insiders case can be written as:

$$\sum_{t=0}^{\infty} \beta^t \upsilon(N_t)\xi(N_t)^{\lambda} k_t^{a\lambda}$$

where

$$\upsilon(N_t) = \frac{\nu(N_t)-1}{\nu(N_t)\left\{\frac{1-a}{b}+[\nu(N_t)-1]\right\}^{\frac{1-\lambda}{\lambda}}}$$

Since $\lambda > 0$, the social planner's objective function in the Government of Insiders case is equivalent to:

$$\sum_{t=0}^{\infty} \beta^t \upsilon(N_t)\xi(N_t) k_t^{a}$$

Thus, the problem of the Government of Insiders is to find a sequence of the form $\left\{k_{t+1}, N_{t+1}\right\}_{t=0}^{\infty}$ so as to maximize the above expression, subject to:

$$(1+g_A)k_{t+1} = a\beta\left[1-\tilde{\psi}(N_{t+1}-N_t)y_t - \hat{\psi}N_t\right]\xi(N_t)k_t^a \ , \forall \mathrm{t} \in \mathbb{N}_+ \tag{A.3}$$

and $\left(k_0, N_0\right) \in \left(0,\infty\right) \times \left[\frac{1-a-b-\zeta}{1-\zeta}, \frac{1}{\hat{\psi}}\right)$ given (A.4)

The Euler-Lagrange conditions associated with this problem are given by:

$$\begin{aligned} &a\upsilon(N_{t+1})\xi(N_{t+1})k_{t+1}^{a-1} - \beta^{-1}\mu_t^{GI}(1+g_A) + \\ &+\mu_{t+1}^{GI}a^2\beta\left[1-\tilde{\psi}(N_{t+2}-N_{t+1})-\hat{\psi}N_{t+1}\right]\xi(N_{t+1})k_{t+1}^{a-1} = 0 \end{aligned} \tag{A.5}$$

and

$$\begin{aligned} &\left[\frac{\upsilon'(N_{t+1})}{\upsilon(N_{t+1})}+\frac{\xi'(N_{t+1})}{\xi(N_{t+1})}\right]\upsilon(N_{t+1})\xi(N_{t+1})k_{t+1}^a - \beta^{-1}\mu_t^{GI}a\beta\tilde{\psi}\xi(N_t)k_t^a + \\ &+\mu_{t+1}^{GI}a\beta\left\{(\tilde{\psi}-\hat{\psi})+\left[1-\tilde{\psi}(N_{t+2}-N_{t+1})-\hat{\psi}N_{t+1}\right]\frac{\xi'(N_{t+1})}{\xi(N_{t+1})}\right\}\xi(N_{t+1})k_{t+1}^a \end{aligned} \tag{A.6}$$

where μ_t^{GI} is the Lagrange multiplier associated with (A.3).

Consider, any steady state such that:

$$\begin{aligned} &\ldots = k_{t-1} = k_t = k_{t+1} = \ldots = k^{GI} \\ &\ldots = N_{t-1} = N_t = N_{t+1} = \ldots = N^{GI} \\ &\ldots = \mu_{t-1}^{GI} = \mu_t^{GI} = \mu_{t+1}^{GI} = \ldots = \mu^{GI} \end{aligned}$$

In any such steady state the Euler-Lagrange conditions (A.5) and (A.6) reduce to:

$$\upsilon(N^{GI}) = \mu^{GI}\left(1-\hat{\psi}N^{GI}\right)(1-a\beta) \tag{A.7}$$

$$\left[\frac{\upsilon'(N^{GI})}{\upsilon(N^{GI})}+\frac{\xi'(N^{GI})}{\xi(N^{GI})}\right]\upsilon(N^{GI})=a\mu^{GI}\tilde{\psi}-a\beta\mu^{GI}\left[(\tilde{\psi}-\hat{\psi})+(1-\tilde{\psi}N^{GI})\frac{\xi'(N^{GI})}{\xi(N^{GI})}\right] \tag{A.8}$$

Combining (A.7) and (A.8) gives:

$$(1-\hat{\psi}N^{GI})\left[(1-a\beta)\frac{\upsilon'(N^{GI})}{\upsilon(N^{GI})}+\frac{\xi'(N^{GI})}{\xi(N^{GI})}\right]=a\beta\left[(\beta^{-1}-1)\tilde{\psi}+\hat{\psi}\right] \tag{A.9}$$

It follows from the proof of Proposition 2 that $(1-\hat{\psi}N)\frac{\xi'(N)}{\xi(N)}$ is a positive function of *N*. Similarly, it follows by differentiating $\upsilon(N)$, defined in (51), with respect to *N*:

$$\frac{\upsilon'(N)}{\upsilon(N)}=\frac{\lambda(1-a-b-\zeta)v(N)^2}{N^2}\left\{\frac{1}{v(N)-1}-\frac{1}{v(N)}-\frac{(1-\lambda)b}{\lambda\left[1-a-b+bv(N)\right]}\right\} \tag{A.10}$$

Hence, given [R1] and [R2], $\frac{\upsilon'(N)}{\upsilon(N)}\gtreqless 0$ if and only if $\left\{\frac{1}{v(N)-1}-\frac{1}{v(N)}-\frac{(1-\lambda)b}{\lambda\left[1-a-b+bv(N)\right]}\right\}\gtreqless 0$.

Then, it follows after some algebra, that $\frac{\upsilon'(N)}{\upsilon(N)}\gtreqless 0$ if and only if $v(N)^2-\frac{1}{1-\lambda}v(N)-\frac{\lambda(1-\alpha-b)}{(1-\lambda)b}\lesseqgtr 0$ or $\frac{\upsilon'(N)}{\upsilon(N)}\gtreqless 0$ if and only if $\left[v(N)-\underline{v}(N)\right]\left[v(N)-\overline{v}(N)\right]\lesseqgtr 0$, where $\underline{v}(N)<0$ and $\overline{v}(N)>\frac{1}{1-\lambda}$, $\forall N\in\mathcal{N}_1\equiv\left[\frac{1-\alpha-b-\zeta}{1-\zeta},\frac{1}{\hat{\psi}}\right)$. Therefore, $\frac{\upsilon'(N)}{\upsilon(N)}\gtreqless 0$ if and only if $v(N)\lesseqgtr\overline{v}(N)$. But, it follows from Proposition 1, that $v(N)<\frac{1}{1-\lambda(1-\zeta)+\lambda\hat{\psi}(1-a-b-\zeta)}$, $\forall N\in\mathcal{N}_1$. And, therefore, $v(N)<\overline{v}(N)$ as $\frac{1}{1-\lambda(1-\zeta)+\lambda\hat{\psi}(1-a-b-\zeta)}<\frac{1}{1-\lambda}$, which, of course, is always true. Hence, $(1-\hat{\psi}N)\frac{\upsilon'(N)}{\upsilon(N)}$ is a positive function of *N*, for all $N\in\mathcal{N}_1$. It follows that the left hand side of (A.9) is a positive function of *N*, for all $N\in\mathcal{N}_1$. Clearly, $(1-\hat{\psi}N)\frac{\xi'(N)}{\xi(N)}=(1-\hat{\psi}N)\frac{\upsilon'(N)}{\upsilon(N)}=0$, for $\overline{N}_1=\frac{1}{\hat{\psi}}$.

Therefore, the left hand side of (A.9) is equal to zero, for $N=\overline{N}_1=\frac{1}{\hat{\psi}}$. Further, it follows from (A.10) that, given [R1] and [R2], $(1-\hat{\psi}N)\frac{\upsilon'(N)}{\upsilon(N)}$ approaches $+\infty$ as *N* approaches $\underline{N}_1=\frac{1-\alpha-b-\zeta}{1-\zeta}$ and $(1-\hat{\psi}N)\frac{\xi'(\underline{N}_1)}{\xi(\underline{N}_1)}>0$. Therefore, it follows that the left hand side of (A.9) approaches $+\infty$ as *N* approaches $\underline{N}_1=\frac{1-\alpha-b-\zeta}{1-\zeta}$. Furthermore, it follows that, given [R1] and

[R2], $(1-\hat{\psi}N)\frac{\xi'(N)}{\xi(N)}$ is a strictly decreasing function of N, $\forall N \in \mathcal{N}_1$. And, in particular, that $\frac{d\left[(1-\hat{\psi}N)\xi'(N)/\xi(N)\right]}{dN}<0$, $\forall N \in \mathcal{N}_1$. To see this, observe from Proposition 2 that $\frac{d\left[(1-\hat{\psi}N)\xi'(N)/\xi(N)\right]}{dN} \gtreqless 0$ if and only if $\frac{\chi'(N)N}{\chi(N)} \gtreqless \frac{1}{1-\hat{\psi}N}$, where:

$\chi(N)=\frac{1-\zeta}{\zeta}-\frac{\lambda b(1-a-b-\zeta)v(N)\left[v(N)-1\right]}{N\left[1-a-b+bv(N)\right]}=\frac{1}{1-\alpha-b}\frac{\xi'(N)N}{\xi(N)}>0$. Then, observe that

$$\frac{\chi'(N)N}{\chi(N)}=\frac{1}{\chi(N)}\left\{\left[\frac{1-\zeta}{\zeta}-\chi(N)\right]-\left[\frac{1-\zeta}{\zeta}-\chi(N)\right]^2\frac{bv(N)^2+2(1-a-b)v(N)-(1-a-b)}{b\left[v(N)-1\right]^2}\right\}.$$

Therefore, $\frac{d\left[(1-\hat{\psi}N)\xi'(N)/\xi(N)\right]}{dN} \gtreqless 0$ if and only if

$$\left[\frac{1-\zeta}{\zeta}-\chi(N)\right]^2\frac{bv(N)^2+2(1-a-b)v(N)-(1-a-b)}{b\left[v(N)-1\right]^2}-\left[\frac{1-\zeta}{\zeta}-\chi(N)\right]+\frac{\chi(N)}{1-\hat{\psi}N} \lesseqgtr 0 \qquad \text{(A.11)}$$

Then, note that given [R1] and [R2], $\frac{bv(N)^2+2(1-a-b)v(N)-(1-a-b)}{b\left[v(N)-1\right]^2}>1$. And, therefore, the left hand side in (A.11) is greater than zero, provided that:

$$\frac{\chi(N)}{1-\hat{\psi}N}>\frac{1-\zeta}{\zeta}-\chi(N) \qquad \text{(A.12)}$$

But, it follows as in the proof of Proposition 2 that (A.12) holds if and only if

$$v(N)^2-\left[1+\tilde{v}(N)\right]v(N)-\frac{1-\alpha-b}{b}\tilde{v}(N)<0 \qquad \text{(A.13)}$$

where $\tilde{v}(N)=\frac{(1-\zeta)N}{\lambda\zeta(1-a-b-\zeta)(2-\hat{\psi}N)}$. Since $v(N)<\tilde{v}(N)$, $\forall N \in \mathcal{N}_1$, is a sufficient condition for (A.13). And, since, given [R1] and [R2], $v(N)$ is strictly increasing function of N in $\mathcal{N}_1$, so that it achieves its supremum in $\mathcal{N}_1$ at the end point $\bar{N}_1=\frac{1}{\hat{\psi}}$, it follows that a sufficient condition for (A.13) is that:

$\frac{1}{1-\lambda(1-\zeta)+\lambda\hat{\psi}(1-a-b-\zeta)}<1+\frac{\frac{1-\zeta}{\zeta}N}{\lambda\left(2-\hat{\psi}N\right)(1-a-b-\zeta)}$, $\forall N \in \mathcal{N}_1$. But, it follows, after some algebra, that the above relation holds, if and only if, $\frac{1}{\zeta 1-\zeta}>\lambda^2$. But, this of course is always true, since $\zeta, \lambda \in \left(0,1\right)$.

Finally, it remains to show that given [R1], [R2] and [R4], $\frac{d\left[(1-\hat{\psi}N)\upsilon'(N)/\upsilon(N)\right]}{dN}<0$, $\forall N \in \mathcal{N}_1$.

To prove this, observe from (A.10) that $\frac{d\left[(1-\hat{\psi}N)\upsilon'(N)/\upsilon(N)\right]}{dN}<0$ if and only if $v(N) < \frac{2(1-a-b)+\frac{b}{1-\lambda}}{-b\left(2-\frac{1}{\lambda}\right)}$. Or, since $v(N)$ is a strictly increasing function of N in $\mathcal{N}_1$, if

$\frac{1}{1-\lambda(1-\zeta)+\lambda\hat{\psi}(1-a-b-\zeta)} < \frac{2(1-a-b)+\frac{b}{1-\lambda}}{-b\left(2-\frac{1}{\lambda}\right)}$, $\forall N \in \mathcal{N}_1$. But, this is what [R4] implies.

Therefore, given [R1], [R2] and [R4], $\frac{d\left[(1-\hat{\psi}N)\upsilon'(N)/\upsilon(N)\right]}{dN}<0$, $\forall N \in \mathcal{N}_1$. It follows that the left hand side of (A.9) is a strictly decreasing function of *N*. Then, it follows, by standard arguments, that there exists a unique N^{GI} in the interior of $\mathcal{N}_1$, such that (A.9) holds. And, likewise, it follows that there exists a unique $k^{GI} \in (0,\infty)$ such that (A.3) holds for $N_t = N_{t+1} = ... = N^{GI}$. And,

$$k^{GI} = \left[\frac{a\beta(1-\hat{\psi}N^{GI})\xi(N^{GI})}{1+g_A}\right]^{\frac{1}{1-a}} \tag{A.14}$$

Hence, $\left(k^{GI}, N^{GI}\right) \in (0,\infty) \times \operatorname{int}\mathcal{N}_1$ is the unique steady state in the Government of Insiders social planner's problem.

Consider, now, the problem of the Median Voter social planner:

$$\max_{\{k_{t+1},N_{t+1}\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t \ln(1-ab)\left[1-\tilde{\psi}(N_{t+1}-N_t)-\hat{\psi}N_t\right]\xi(N_t)k_t^a$$

subject to (A.3) and (A.4).

The Euler – Lagrange equations associated with this problem are given by:

$$\begin{aligned} 1 &= \mu_t^{MV}\left[1-\tilde{\psi}(N_{t+1}-N_t)-\hat{\psi}N_t\right]\xi(N_t)k_t^a - \\ &-a\beta\mu_{t+1}^{MV}\left[1-\tilde{\psi}(N_{t+2}-N_{t+1})-\hat{\psi}N_{t+1}\right]\xi(N_{t+1})k_{t+1}^a \end{aligned} \tag{A.15}$$

$$\begin{aligned} &\beta^{-1}\tilde{\psi}\left[1-\tilde{\psi}(N_{t+1}-N_t)-\hat{\psi}N_t\right]^{-1} + a\mu_t^{MV}\tilde{\psi}\xi(N_t)k_t^a = \\ &= \left\{\tilde{\psi}-\hat{\psi}+\left[1-\tilde{\psi}(N_{t+2}-N_{t+1})-\hat{\psi}N_{t+1}\right]\frac{\xi'(N_{t+1})}{\xi(N_{t+1})}\right\}\left[1-\tilde{\psi}(N_{t+2}-N_{t+1})-\hat{\psi}N_{t+1}\right]^{-1} + \\ &+a\beta\mu_{t+1}^{MV}\xi(N_{t+1})k_{t+1}^a\left\{\tilde{\psi}-\hat{\psi}+\left[1-\tilde{\psi}(N_{t+2}-N_{t+1})-\hat{\psi}N_{t+1}\right]\frac{\xi'(N_{t+1})}{\xi(N_{t+1})}\right\} \end{aligned} \tag{A.16}$$

where μ_t^{MV} is the Lagrange multiplier associated with (A.3).

Consider any steady state such that:

$$... = k_{t-1} = k_t = k_{t+1} = ... = k^{MV}$$
$$... = N_{t-1} = N_t = N_{t+1} = ... = N^{MV}$$
$$... = \mu_{t-1}^{MV} = \mu_t^{MV} = \mu_{t+1}^{MV} = ... = \mu^{MV}$$

Along any such steady state, the Euler-Lagrange conditions (A.15) and (A.16), reduce to:

$$\frac{1}{\mu^{MV}} = (1-\tilde{\psi}N^{MV})(1-a\beta)\xi(N^{MV})k^{MV^a} = c^{MV} > 0 \tag{A.17}$$

$$(1-\hat{\psi}N^{MV})\frac{\xi'(N^{MV})}{\xi(N^{MV})} = (b^{-1}-1)\tilde{\psi}+\hat{\psi} \tag{A.18}$$

Following the proof of existence and uniqueness of the steady state in the Government of insiders social planner's problem, all that is left to show in order to establish the existence and uniqueness of the steady state in the Median Voter social planner's problem, is to show that the $(1-\hat{\psi}N)\frac{\xi'(N)}{\xi(N)}$ locus takes a value above $\left(\beta^{-1}-1\right)\tilde{\psi}+\hat{\psi}$ for $N = \underline{N}_1$. But, clearly, this is what [R3] achieves. Moreover, k^{MV} is given by (A.14), if $\left(k^{GI}, N^{GI}\right)$ are replaced by $\left(k^{MV}, N^{MV}\right)$ in this equation.

Now, since the RHS of (A.9) and (A.18) are equal, so must be the LHS, therefore:

$$\frac{(1-\hat{\psi}N^{GI})}{ab}\left[(1-ab)\frac{\upsilon'(N^{GI})}{\upsilon(N^{GI})}+\frac{\xi'(N^{GI})}{\xi(N^{GI})}\right] = (1-\hat{\psi}N^{MV})\frac{\xi'(N^{MV})}{\xi(N^{MV})} \tag{A.19}$$

Further, since $\left(1-\hat{\psi}N^{GI}\right)\frac{\upsilon'(N^{GI})}{\upsilon(N^{GI})} > 0$, $\forall N \in \mathcal{N}_1$, and $a, \beta \in (0,1)$, (A.19) implies:

$$\frac{(1-\hat{\psi}N^{GI})}{a\beta}\frac{\xi'(N^{GI})}{\xi(N^{GI})} < (1-\hat{\psi}N^{MV})\frac{\xi'(N^{MV})}{\xi(N^{MV})} \tag{A.20}$$

But, it follows from previously in this proof that $\frac{d\left[(1-\hat{\psi}N)\xi'(N)/\xi(N)\right]}{dN} < 0$. Therefore, (A.20) implies that $N^{MV} < N^{GI}$ (See Figure 8).

Q.E.D.

The Barro Regressions with the Relative Wage Premium[36]

We estimate regressions of the form:

$$\gamma_{it} = a + X'_{it}b + u_{it}, \quad i = 1,...N; \;\; t = 1,...,T \qquad \text{(BR)}$$

where:

γ_{it} is the dependent variable, a is a constant, X_{it} is a vector of exogenous variables, and b and u_{it} are the vector of the regression coefficients and the error terms, respectively.

The dependent variable are the average annual growth rates of real per capita GDP for each of the following five-year periods: 1970-1975, 1975-1980, 1980-1985, 1985-1990, 1990-1995, 1995-2000, 2000-2005 and 2005-2010. The explanatory variables in X_{it}, include the level of real per capita GDP at the start of each period, a measure of school attainment at the start of each period, period averages of the ratio of total investment to GDP, government non-wage consumption as share of GDP, exports as share of GDP and population growth. All these variables have been found to be important determinants of growth (see, among many others, Levine and Renelt (1992), Barro (2000) and Barro and Sala-i-Martin (2004, Chapter 12)). Also included in the vector of the explanatory variables, are period averages of the wage premium in the public sector, the ratio of general government employees to total employees and total government consumption as share of GDP. In particular, the average growth rates of real per capita GDP and population are computed from time $t+1$ to $t+5$. Averages of the ratio of total investment to GDP, government non-wage consumption as share of GDP, exports as share of GDP, the wage premium in the public sector, the ratio of general government employees to total employees and total government consumption as share of GDP are over 1970-1974, 1975-1979,…,2005-2010.

Table 1: Descriptive statistics

	Mean	Max.	Min.	Std. Dev.	Observations
Growth rate of real per capita GDP	0.021	0.08	-0.021	0.018	156
Log of real per capita GDP at the start of each period	11.31	17.04	9.17	1.79	156
Log of average years of schooling at the start of each period	2.141	2.58	1.217	0.27	160
Population growth	0.008	0.04	-0.007	0.008	156
Government non-wage consumption-to-GDP ratio	0.076	0.138	0.031	0.021	150
Investment-to-GDP ratio	0.227	0.362	0.164	0.04	156
Exports-to-GDP ratio	0.305	0.911	0.065	0.161	151
Wage premium	1.171	2.418	0.527	0.336	149
General government employees to total employees	0.211	0.394	0.072	0.071	150
Total government consumption-to-GDP ratio	0.19	0.289	0.096	0.041	150

[36] The notation in this part is unrelated to anything defined in earlier sections / appendices.

Regressions for real per capita growth rate – 20 OECD countries

We estimate equation (BR) using a panel of twenty OECD countries: Austria, Australia, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Israel, Italy, Japan, Korea, Norway, Portugal, Spain, Sweden, UK and US. In order to account for non-linearities in the relationship between growth rates and the initial GDP, we also include the square of the initial GDP as an explanatory variable (see also Barro and Sala-i-Martin (2004, Chapter 12)). Table 1 shows some descriptive statistics of the data used and Table 2 shows the results.

Table 2: Regressions for real per capita growth rate – 20 OECD countries

Variable	**Dependent variable: Real per capita GDP growth rate**						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Constant	0.168*** (2.911)	0.172*** (2.681)	0.175*** (3.203)	0.168*** (2.767)	0.121** (2.295)	0.153*** (3.025)	0.044 (0.914)
Log(per capita GDP)	-0.018** (-2.355)	-0.024*** (-2.681)	-0.018** (-2.484)	-0.017** (-2.218)	-0.013* (-1.717)	-0.013** (-2.263)	0.003 (0.433)
Log(per capita GDP) squared	0.0008*** (2.61)	0.001*** (2.846)	0.0008*** (2.81)	0.0008*** (2.442)	0.0006** (2.142)	0.0006*** (2.693)	1.40E-0.6 (-0.005)
Log of years of schooling	-0.009 (-1.311)	-0.013 (-1.601)	-0.001 (-1.284)	-0.007 (-1.024)	-0.012 (-1.514)	-0.01 (-1.463)	-0.016* (-1.973)
Population growth	0.017 (0.112)	0.247 (1.488)	0.036 (0.239)	0.012 (0.074)	0.187 (1.279)	0.017 (0.104)	0.168 (1.193)
Government non-wage consumption-to-GDP ratio	-0.327*** (-5.319)		-0.337*** (-6.402)	-0.298*** (-5.277)	-0.24*** (-4.578)	-0.333*** (-5.059)	
Investment-to-GDP ratio	0.018 (0.465)	0.067* (1.726)		0.014 (0.322)	-0.014 (-0.353)	0.005 (0.12)	-0.019 (-0.447)
Exports-to-GDP ratio	0.0195* (1.773)	0.015 (1.344)	0.019* (1.743)		0.021* (1.777)	0.021* (1.85)	0.022* (1.80)
Wage premium (WPR)	-0.014*** (-3.183)	-0.007 (-1.609)	-0.014*** (-3.125)	-0.015*** (-3.504)		-0.016*** (-2.915)	
General government employees / total employees						-0.021 (-1.374)	
Total government consumption-to-GDP ratio							-0.143*** (-3.879)
Number of observations	149	149	149	149	150	149	150
Adjusted R-squared	0.309	0.221	0.312	0.275	0.285	0.307	0.281

Notes: (i) Estimates are based on pooled OLS with robust standard errors, (ii) t-statistics in parenthesis, (iii) * indicates statistical significance at the 10% level of significance, ** at the 5% level, and *** at the 1% level.

Data sources and definitions

Countries: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Israel, Italy, Japan, Korea, Norway, Portugal, Spain, Sweden, UK and US.

Variables:

Our main data source is the OECD Economic Outlook no. 90. Missing values for some specific time periods/variables have been completed from the OECD Economic Outlook no. 88 and 85, OECD Aggregate National Accounts and AMECO.

Variable	Source
Nominal Gross Domestic Product	OECD Economic Outlook and AMECO
Real Gross Domestic Product	OECD Economic Outlook and AMECO
Total compensation of employees	OECD Economic Outlook and OECD Aggregate National Accounts
Government final consumption expenditure	OECD Economic Outlook
Government final non-wage consumption expenditure	OECD Economic Outlook and AMECO
Government final wage consumption expenditure[1]	OECD Economic Outlook and AMECO
Exports of goods and services	OECD Economic Outlook
Dependent employment - Total economy (Total employees)[2]	OECD Economic Outlook
Dependent employment in the private sector (Private sector employees)[2]	OECD Economic Outlook
General government employment[3]	OECD Economic Outlook
Working age population 15-64	OECD Economic Outlook
Average years of total schooling (age group over 25)	Barro, R. and J.W. Lee, 2010, NBER Working Paper No. 15902.
Gross fixed capital formation	OECD Economic Outlook
Total compensation of employees in the private sector	Own calculations (Total compensation of employees minus government final wage consumption expenditure)
Compensation rate in the private sector	Own calculations (Total compensation of employees in the private sector divided by private sector employees)
Compensation rate in the public sector	Own calculations (Government final wage consumption expenditure divided by government employment)
Public sector wage premium	Own calculations (Compensation rate in the public sector divided by the compensation rate in the private sector)

1. For Australia, government final wage consumption is computed as $CGW = WSSS - WSSE * EEP$, where $WSSS$ is total compensation of employees, $WSSE$ is the compensation rate in the private sector and EEP is dependent employment in the private sector. Then, government final wage consumption expenditure is computed as $CGNW = CG - CGW$, where CG is total government consumption.
2. For Germany and Korea, total dependent employment, EE, and dependent employment in the private sector, EEP, are respectively computed from the following relationships: $WSST = WSSS / EE$ and $WSSE = (WSSS - GCW) / EEP$, where $WSST$ is the compensation rate of the total economy, $WSSE$ is the compensation rate in the private sector, $WSSS$ is total compensation of employees, and GCW is government final wage consumption expenditure. For Israel, EE is computed as $EE = ET - ES$, where ET is total employment and ES is total self-employment. Then, EEP is computed as $EEP = EE - GE$, where GE is general government employment.
3. For Australia, Austria, Germany, Greece and Korea, general government employment is computed as $GE = EE - EEP$, where EE is total dependent employment and EEP is dependent employment in the private sector.