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ABSTRACT

Monopoly Rights can Reduce Income Big Time*

We study a two-sector version of the neoclassical growth model with coalitions of factor suppliers in the capital producing sectors. We show that if the coalitions have monopoly rights, then they block the adoption of the efficient technology. We also show that blocking leads to a decrease in the productivity of each capital-producing sector and to an increase in the relative price of capital; as a result capital stock and production fall in each sector. We finally show that the implied fall in the level of *per capita* income can be large quantitatively.

JEL Classification: E00

Keywords: capital accumulation, monopoly rights, technology adoption, total factor productivity and vested interests

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1 Introduction

The per-capita income of the richest countries is many times larger than that of the poorest countries; see e.g. Parente and Prescott (1993), Hall and Jones (1999), and McGratten and Schmitz (1999) for estimates. The objective of a successful theory of development must be to explain the income level differences across countries without contradicting the growth facts. Since differences in total factor productivity play an important role, a successful theory must also be a theory of large cross-country differences in TFP [Klenow and Rodriguez-Clare (1997) and Prescott (1998)]. One possibility is that the cross-country differences in TFP come from cross-country differences in monopoly rights. If vested interest groups of factor suppliers are granted monopoly rights, then they can block the adoption of the most efficient technologies or the best-practice working arrangements. Blocking is optimal if it increases the real income of the factor suppliers. Real-world examples of vested interest groups of factor suppliers are brotherhoods, guilds, professional associations, trade unions, and the like, and there is mounting evidence that they do block; see e.g. Mokyr (1990), McKinsey-Global-Institute (1999), Parente and Prescott (1999,2000), and Schmitz (2001b).

Here we explore the quantitative implications of monopoly rights. Our main innovation compared to the existing literature is to embed monopoly rights in the neoclassical growth model with capital, where capital refers to tangible capital. The value added of having capital is twofold. It allows us to study the interaction between technology adoption and investment. In particular, we can study the conjecture of Parente and Prescott (1999) that monopoly rights reduce investment, which magnifies their effect on per-capita income. Having capital also allows us to replicate the standard growth facts. Our theory of development is therefore a theory of growth as well, which is desirable because development and growth issues are intimately linked.

Our model economy is small and open. There are two final goods, which we call services and manufacturing, and there are many intermediate goods. The service good and the intermediate goods are produced with capital and labor and the manufacturing

good is produced with the intermediate goods. The service good can only be consumed and it is not tradable. The manufacturing good can be both consumed and invested and it is tradable. The intermediate goods are not tradable. In each intermediate good sector there are insiders. The institutional arrangement is such that the insiders of an intermediate good sector form a coalition that chooses the marginal product of insider labor. The coalitions either have monopoly rights or they do not have monopoly rights. We define these two cases as follows. That the coalitions have monopoly rights means that the outsiders are restricted to work in the intermediate goods sectors, so outsider labor in the intermediate good sectors is less productive than is possible. The insiders then face only restricted competition from the outsiders and they can choose to produce less efficiently than is possible. That the insiders do not have monopoly rights means that the outsiders are not restricted to work in the intermediate goods sectors, so outsider labor in the intermediate good sectors is as productive as possible. The insiders then face unrestricted competition from the outsiders, so if the coalitions choose to produce less efficiently than is possible, then the insiders will be less productive than the outsiders and so they will not be employed in the intermediate good sectors.

We derive the following analytical results. (i) When they have monopoly rights the coalitions of insiders choose inefficient technologies; when they do not have monopoly rights, the frontier technology is used. (ii) The relative price of the domestic service good in terms of the domestic manufacturing good is lower with monopoly rights; by construction, the relative price of the domestic manufacturing good in terms of the foreign manufacturing good is constant. (iii) All sectors' capital-labor ratios and the (economy-wide) per-capita income are lower with monopoly rights. Results (ii) and (iii) imply that the relative price of capital goods in terms of consumption goods be higher when per-capita income is lower. Jones (1994), Chari et al. (1996), Jovanovic and Rob (1997), Eaton and Kortum (2001), and Restuccia and Urrutia (2001) report cross-country evidence consistent with this prediction. Results (ii) and (iii) also imply that the relative price of non-tradable consumption goods in terms of tradable capital goods be lower when per-

capita income is lower and that the relative price of tradable capital goods be unrelated to per-capita income. Hsieh and Klenow (2002) report cross-country evidence consistent with these predictions.

We derive the following quantitative results. Given plausible parameter values, monopoly rights lead to a substantial decrease in the level of per-capita income evaluated at purchasing-power-adjusted international prices. Specifically, calibrating our model economy to the 1996 Benchmark Study of the Penn World Tables, we find that monopoly rights can explain a difference in per-capita incomes evaluated at international prices of a factor 7.1. This difference is more than twice of 2.7 found by Parente and Prescott (1999) for a model economy without capital. Interestingly, we obtain such a sizeable income difference with a narrow concept of tangible capital with a capital share of 0.4, which is defensible for poorer countries [Gollin (2002)]. We conclude from our quantitative findings that modeling the interaction between technology adoption and investment is key to understanding the quantitative implications of monopoly rights.

Our paper is placed in the branch of the development literature that seeks to explain the observed differences in cross-country per capita incomes under the assumption that the most productive technology is freely available once it is invented. The most closely related papers to our's are Holmes and Schmitz (1995), Parente and Prescott (1999,2000), and Herrendorf and Teixeira (2002), who all study the implications of monopoly rights but abstract from capital accumulation. There are several other related papers: Mankiw et al. (1992) emphasize the role of intangible capital, which increases the capital share; Chari et al. (1996), Jovanovic and Rob (1997), Eaton and Kortum (2001), and Restuccia and Urrutia (2001) emphasize the role of policy distortions, which implies a higher relative price of capital; Parente et al. (2000) emphasize the role of home production, which leads to substantial non-measured income in poor countries; Acemoglu and Zilibotti (2001) emphasize the role of skill mismatch, which implies that the technologies developed in rich countries are not suited for poor countries; Schmitz (2001a) emphasizes the role of inefficient government production of investment goods. We view intangible capital, policy

distortions, home production, skill mismatch, and government production of investment goods as alternative explanations of TFP differences that are complementary to our's. Nonetheless, our results suggest that monopoly rights are an important ingredient of the story.

2 Model Economy

2.1 Environment

We use the following environment. There are two types of individuals: a unit rectangle of outsiders and a unit rectangle of insiders. All outsiders are identical. In contrast, there are unit intervals of insiders of type i , $i \in [1, 2]$. All individuals are endowed with one unit of time in each period and with a positive capital stock in the first period. There are two final goods called x and y and a continuum of intermediate goods called z_j , $j \in [1, 2]$. x is a service good, which can only be consumed, and y is a manufacturing good, which can be both consumed and invested. The service good and the intermediate goods are non-tradable and the manufacturing good is tradable. The economy is small in that it does not affect the world market price of the tradable good.

We start by describing the problems of the two representative individuals:

$$\max_{\{x_{it}, y_{it}, k_{it+1}\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t u(x_{it}, y_{it}) \quad \text{s.t.} \quad p_{xt}x_{it} + y_{it} + k_{it+1} = (1 + r_t - \delta)k_{it} + w_{it}, \quad (1)$$

$$x_{it}, y_{it}, k_{it+1} \geq 0, \quad k_{i0} > 0 \text{ given.}$$

The utility function has the form

$$u(x, y) = \frac{(x^\alpha y^{1-\alpha})^{1-\rho}}{1-\rho}.$$

We use the following notation. The subscript ι can take the values o for outsider and $i \in [1, 2]$ for insider of type i ; $\beta \in (0, 1)$ is the discount factor; p_{xt} is the price of x_t in

terms of the numeraire y_t (the manufacturing good); k_{it+1} is the capital stock for period $t + 1$ and k_{it} is the installed capital stock held by the representative individual of type i ; r_t and w_t are the rental rate of installed capital and the wage rate, both expressed in terms of the numeraire; $\delta \in [0, 1]$ is the depreciation rate of installed capital; $\alpha \in (0, 1)$ is the expenditure share of x_{it} and $\rho \in [0, \infty)$ is the intertemporal elasticity of substitution.

Next we turn to the production side of the model economy. There is perfect competition and free entry and the technology has constant returns to scale, so equilibrium profits will be zero. It is therefore without loss of generality that we have omitted profits from the individuals' problems. The representative firm in the service sector faces the following sequence of static problems:

$$\begin{aligned} \max_{x_t, k_{xt}, l_{xot}, l_{xit}} & \left(p_{xt}x_t - r_t k_{xt} - w_{ot}l_{xot} - \int_1^2 w_{it}l_{xit}di \right) \\ \text{s.t. } & x_t = k_{xt}^\theta \left[\gamma^t \left(l_{xot} + \int_1^2 l_{xit}di \right) \right]^{1-\theta}, \quad x_t, k_{xt}, l_{xot}, l_{xit} \geq 0, \end{aligned} \quad (2)$$

where $\theta \in (0, 1)$ is the capital share, $\gamma - 1 \in [0, \infty)$ is the exogenous growth rate of labor-augmenting technical progress, k_{xt} is capital, l_{xot} is outsider labor, and l_{xit} is insider labor of type i , $i \in [1, 2]$. Note that outsider and insider labor are equally productive in the service sector, so in equilibrium both types will work here only if both wages are equal. The representative firm in the manufacturing sector faces the following sequence of static problems:

$$\max_{y_t, z_{jt}} \left(y_t - \int_1^2 p_{zjt}z_{jt}dj \right) \quad \text{s.t.} \quad y_t = \left(\int_1^2 z_{jt}^{\frac{\sigma-1}{\sigma}} dj \right)^{\frac{\sigma}{\sigma-1}}, \quad y_t, z_{jt} \geq 0, \quad (3)$$

where p_{zjt} is the price of intermediate good z_{jt} in terms of the numeraire y_t and $\sigma \in (0, 1)$ is the elasticity of substitution between any two intermediate goods. As Parente and Prescott (1999), we will need that the manufacturing sector's demand for each intermediate good is inelastic: $\sigma < 1$. An inelastic demand for each intermediate good can be obtained by considering sufficiently broad categories of goods (BMW cars versus Mer-

cedes cars or cars versus bicycles). The representative firm in the j -th intermediate good sector faces the following sequence of static problems:

$$\begin{aligned} \max_{z_{jt}, k_{zjt}, l_{zjot}, l_{zjit}} & (p_{zjt}z_{jt} - r_t k_{zjt} - w_{ot}l_{zjot} - w_{jt}l_{zjit}) \\ \text{s.t. } & z_{jt} = k_{zjt}^\theta [(1 - \omega)\gamma^t l_{zjot} + \gamma^{\tau_{jt}} l_{zjit}]^{1-\theta}, \quad z_{jt}, k_{zjt}, l_{zjot}, l_{zjit} \geq 0, \end{aligned} \quad (4)$$

where w_{jt} is the wage for insiders of sector j . The exogenous parameter $\omega \in [0, 1)$ measures how strong the monopoly rights are: $\omega = 0$ corresponds to “no monopoly rights” and $\omega > 0$ corresponds to “monopoly rights” that increase in strength in ω . The value of τ_{jt} is decided in period $t - 1$ at the same time when the other decisions of period $t - 1$ are taken. The insiders of sector j then form a coalition that chooses $\tau_{jt} \in (-\infty, t]$ so as to maximize the present value of insider utility. The assumption that the highest possible τ_{jt} equals t implies that the growth rates of the technological frontiers are the same in the intermediate goods sectors and in the service sector. To avoid confusion, note that the growth rates of the chosen technologies of the intermediate good sectors can in principle differ from the growth rate of the frontier technology.

We experimented with two other formulations of the production function of sector j . The first formulation has outsiders and insiders produce with different capital stocks:

$$z_{jt} = k_{zjot}^\theta [(1 - \omega)\gamma^t l_{zjot}]^{1-\theta} + k_{zjit}^\theta (\gamma^{\tau_{jt}} l_{zjit})^{1-\theta}.$$

This could be the case, for example, if the entry of outsiders happened through the entry of new firms that hired only outsiders. We found that this formulation does not make a difference for our results, so choosing our specification is merely a matter of carrying a little less notation. The second formulation has the coalitions choose not only its own productivity but also that of the outsiders:

$$z_{jt} = k_{zjt}^\theta \{ \gamma^{\tau_{jt}} [(1 - \omega)l_{zjot} + l_{zjit}] \}^{1-\theta}.$$

This would be the case if the insiders had more monopoly power than in our specification. We found that with this formulation the balanced growth path (BGP henceforth) with monopoly rights becomes indeterminate, whereas with our specification the BGP is unique (see below).

Trade takes place in sequential markets. In each period there are markets for both final goods, for each intermediate good, for capital, for outsider labor, and for each type of insider labor. The market clearing condition for the intermediate goods are obvious and thus omitted. Denoting aggregate variables by upper-case letters the other market clearing conditions are:

$$\begin{aligned}
X_t &= X_{ot} + \int_1^2 X_{it} di, \\
Y_t + Y_t^* + (1 - \delta) \left(K_{ot} + \int_1^2 K_{it} di \right) &= (Y_{ot} + K_{ot+1}) + \int_1^2 (Y_{it} + K_{it+1}) di, \\
K_{ot} + \int_1^2 K_{it} di &= K_{xt} + \int_1^2 K_{zjt} dj, \\
1 &= L_{xot} + \int_1^2 L_{zjot} dj, \\
1 &= L_{xit} + L_{ziit}, \quad i \in [1, 2].
\end{aligned}$$

The first two market clearing conditions require that the markets for final goods clear, where Y_t^* denotes the imports of Y_t . The last three market clearing conditions require that the factor markets clear. The last market clearing condition assumes that the insiders of a sector can only work in that sector or in the service sector. Since we will restrict our attention to symmetric equilibrium, this is without loss of generality.

Our model economy abstracts from borrowing between insiders and outsiders and between domestic and foreign individuals. This, too, is without loss of generality because we will only compare different balanced growth paths. Without borrowing and lending between domestic and foreign individuals, international trade is balanced in each period: $Y_t^* = 0$. So, the only implication that international trade has here is that the relative price between domestic and foreign manufacturing goods is pinned down at 1.

2.2 Equilibrium

Our environment gives rise to a dynamic game. Since each coalition has strategic power in its sector, care needs to be taken in defining the equilibrium. Since each coalition is small compared to the rest of the economy, however, strategic power on the aggregate is not an issue. We restrict attention to equilibria with the following properties: they are symmetric with respect to each type of individual and to the intermediate goods sectors; they are recursive in that in each period the decision makers condition their actions only on the aggregate state and their own state.

We start the equilibrium definition by specifying the relevant state variables. As before, we denote the economy-wide states by upper-case letters and the individual states by lower-case letters. We will also need several sector-wide states, which we denote by Greek letters. So, for example, T is the average technology in the economy and τ is the technology in an intermediate good sector. Similarly, K and K_i are the average total capital stock and the average capital stock held by the insiders in the economy, κ_i is average insider capital in an intermediate goods sector, and k_o and k_i are the capital stocks of the representative outsider and insider. Finally, F is the frontier technology. To make the notation more compact, we summarize the economy-wide state by $S \equiv (T, K, F)$. The law of motion of S is given by

$$S' = G(S) = (G_T, G_K, G_F)(S).$$

As mentioned before, the frontier grows in discrete steps of length 1: $G_F(T, K, F) = F + 1$. The law of motion of κ_i is given by $\kappa_i' = \varrho_{\kappa_i}(S, \tau, \kappa_i)$. Note that since we look for a symmetric equilibrium, we have dropped the index indicating the specific intermediate good sector, so T and τ are just numbers, not distributions.

We now rewrite the dynamic problems in recursive form. The problems of the three representative firms are static, so we do not need to rewrite them. The problem of the

representative outsider is dynamic. Using his value function, v_o , we can rewrite it as:

$$v_o(S, k_o) = \max_{x_o, y_o, k'_o \geq 0} \{u(x_o, y_o) + \beta v_o(S', k'_o)\} \quad (5)$$

$$s.t. \quad p_x(S)x_o + y_o + k'_o = [1 + r(S) - \delta]k_o + w_o(S), \quad S' = G(S).$$

The solution to the outsider's problem implies the policy function

$$(x_o, y_o, k'_o) = (g_{x_o}, g_{y_o}, g_{k_o})(S, k_o).$$

The problem of the representative insider can be rewritten as:

$$v_i(S, \tau, \kappa_i, k_i) = \max_{x_i, y_i, k'_i \geq 0} \{u(x_i, y_i) + \beta v_i(S', \tau', \kappa'_i, k'_i)\} \quad (6)$$

$$s.t. \quad p_x(S)x_i + y_i + k'_i = [1 + r(S) - \delta]k_i + w_i(S, \tau),$$

$$S' = G(S), \quad (\tau', \kappa'_i) = (\varrho_\tau, \varrho_{\kappa_i})(S, \tau, \kappa_i).$$

The solution to the insider's problem implies the policy function

$$(x_i, y_i, k'_i) = (g_{x_i}, g_{y_i}, g_{k_i})(S, \tau, \kappa_i, k_i)$$

and the indirect utility function

$$\nu_i(S, \tau, \kappa_i, k_i) = u(g_{x_i}(S, \tau, \kappa_i, k_i), g_{y_i}(S, \tau, \kappa_i, k_i)).$$

The problem of the representative coalition is:

$$v_c(S, \tau, \kappa_i) = \max_{\tau' \in (-\infty, G_F(S)+1]} \{\nu_i(S, \tau, \kappa_i, \kappa_i) + \beta v_c(S', \tau', \kappa'_i)\} \quad (7)$$

$$s.t. \quad S' = G(S), \quad \kappa'_i = \varrho_{\kappa_i}(S, \tau, \kappa_i).$$

A solution to the problem of the representative coalition implies the policy function

$$\tau' = \varrho_\tau(S, \tau, \kappa_i).$$

Definition 1 (Equilibrium) *An equilibrium is*

- *price functions* $(p_x, w_o, r)(S)$, $(p_z, w_i)(S, \tau)$;
- *allocation functions for the three types of firms*, $(x, k_x, l_x)(S)$, $y(S)$,
 $(z, k_z, l_{zo}, l_{zi})(S, \tau)$,
- *laws of motion* $S' = G(S)$ and $\kappa'_i = \varrho_{\kappa_i}(S, \tau, \kappa_i)$;
- *value functions* $v_o(S, k_o)$, $v_i(S, \tau, \kappa_i, k_i)$, $v_c(S, \tau, \kappa_i)$;
- *policy functions* $k'_o = g_{ko}(S, k_o)$, $k'_i = g_{ki}(S, \tau, \kappa_i, k_i)$, $\tau' = \varrho_\tau(S, \tau, \kappa_i)$;

such that:

- *given the realizations of prices, the firms' allocations solve their problems;*
- *the value functions* v_o , v_i , *and* v_c *satisfy the Bellman equations as stated in (5), (6), and (7);*
- *the policy functions solve the problems of the representative individuals and the representative coalition, (5), (6), and (7);*
- *the policy functions and the laws of motion are consistent:*

$$G_K(S) = g_{ko}(S, K - K_i) + g_{ki}(S, T, K_i, K_i),$$

$$\varrho_{\kappa_i}(S, T, K_i) = g_{ki}(S, T, K_i, K_i),$$

$$G_T(S) = \varrho_\tau(S, T, K_i);$$

- *markets clear.*

3 Analytical Results

In this section, we study the BGPs of the model economy without and with monopoly rights; recall that these two cases correspond to $\omega = 0$ and $\omega > 0$. We will show that all real variables ascend parallel balanced growth paths but that their levels are higher without monopoly rights.

To ensure that the individual utility functions are finite, we need the standard restriction that the growth rates of the technological frontiers are not too large relative to the discount factor: $\tilde{\beta} \equiv \beta\gamma^{1-\rho} \in (0, 1)$. To ensure the existence of a balanced growth path with monopoly rights, we need some additional restrictions on the parameter values:

Assumption 1

$$\alpha\beta\theta(\gamma + \delta - 1)(2 - \omega) < [\alpha - (1 - \alpha)(1 - \omega)][\gamma^\rho - \beta(1 - \delta)], \quad (8a)$$

$$2\alpha\beta\theta(\gamma + \delta - 1) > (2\alpha - 1)[\gamma^\rho - \beta(1 - \delta)]. \quad (8b)$$

Note that these inequalities are satisfied for standard calibrations like that of Section 4 below.

Proposition 1 (BGP Without Monopoly Rights) *There is a BGP equilibrium. The BGP equilibrium is unique up to who works where. Along the BGP equilibrium*

(i) *the frontier technology is used;*

(ii) $p_{xt} = 1$;

(iii) *the capital stocks and the productions of all sectors grow at rate $\gamma - 1$.*

Proof. See the Appendix.

Note that the BGP equilibrium is unique only up to where the two types work. The reason is that $p_{xt} = 1$ implies that the outsiders are indifferent between working in services and in intermediate goods. Moreover, if the coalition of a sector adopts the frontier technology the insiders are indifferent too; if the coalition adopts an inefficient technology the insiders strictly prefer to work in services. So irrespective of which technology the insider coalitions choose, the most efficient technology is used in equilibrium.

Proposition 2 (BGP With Monopoly Rights) *Suppose $\omega > 0$ and Assumption 1 holds. Then there is a unique BGP equilibrium. Along the BGP equilibrium*

- (i) inefficient technologies are used: $t - \tau_t$ is constant and larger than zero;*
- (ii) $p_{xt} < 1$;*
- (iii) the capital stocks and the productions of all sectors grow at rate $\gamma - 1$;*
- (iv) the outsiders work only in the service sector but are indifferent, the insiders work only in their intermediate good sector and strictly prefer that;*
- (v) the capital–labor ratios of all sectors, the production of the intermediate goods sectors, and total production are smaller than without monopoly rights;*
- (vi) if $\alpha > 0.5$ the capital stocks and the productions of all sectors are smaller than without monopoly rights.*

Proof. See the Appendix.

Why does the representative coalition find it optimal to choose inefficient technologies? A monopolist producer in an intermediate sector would choose a high relative price so as to restrict production. The coalition cannot directly choose a high relative price, but it can do so indirectly by choosing an inefficient technology. Assuming that the demand for intermediate goods is sufficiently inelastic, the choice of an inefficient technology increases the relative price by more than it decreases the insider marginal product. Thus, it increases the insiders' real income. The extent to which the coalitions can increase their real income is limited by the possibility that the outsiders enter the intermediate goods sectors if the relative price of intermediate goods has risen sufficiently. When this happens, the relative price is determined by the requirement that the outsiders earn the same wage in the service sector as in the intermediate good sector. Choosing yet more inefficient technologies then only decreases the marginal product of the insiders, and so insider real income. Putting the two arguments together shows that the equilibrium choice of technology must be such that the outsiders are just made indifferent between working in services and the intermediate good sector. Why do monopoly rights reduce the price of services in terms of the manufacturing good? The equilibrium price of intermediate

goods in terms of domestic manufacturing goods must be equal to 1. Since we do not have barriers to the international trade of the manufacturing good, its price in terms of the foreign manufacturing goods must equal 1 too. An increase in the relative price of the intermediate and the manufacturing goods in terms of the domestic service good then requires a decrease in the relative price of the domestic service good. This is possible because the service good is not tradable.

It is straightforward to show that Kaldor's stylized growth facts hold along both BGPs. In particular, output and capital per capita are growing at a constant rate and the capital–output ratios, the income shares of capital and labor, and the rate of return on capital are constant. Consequently, our model economy could also be used to analyze the growth experiences of single countries or of groups of countries. We plan to do this in future research about the transitional paths that recent growth miracles have taken.

An important implication of Proposition 2 is that having monopoly rights in the intermediate goods sectors reduces the capital–labor ratios of *all* sectors. This comes about because along a BGP where the outsiders work only in the service sector and the insiders work only in their intermediate good sector, the Euler equations reduce to

$$\theta \left(\frac{\gamma^{\tau_t}}{K_{zt}} \right)^{1-\theta} = p_{xt} \theta \left(\frac{\gamma^t}{K_{xt}} \right)^{1-\theta} = \frac{\gamma^\rho}{\beta} - 1 + \delta.$$

The direct effect of monopoly rights is to decrease productivity in the intermediate goods sectors: $\tau_t < t$. This decreases the capital–labor ratio in the intermediate goods sectors. Notice that there is no relative price effect in the intermediate good sector because $p_{zt} = 1$ in symmetric equilibrium. The indirect effect of monopoly rights is to decrease the relative price of services: $p_{xt} = (1-\omega)^{1-\theta} < 1$. This decreases the capital–labor ratio of the service sector. In other words, capital provides an amplification mechanism by which monopoly rights in one part of the economy affect the part of the economy that is free of them.¹ It is for this reason that below we will find much larger quantitative effects of monopoly

¹In independent research, Schmitz (2001a) made a related point: If the government produces certain investment goods inefficiently, then this reduces the labor productivity of the sectors that use these investment goods.

rights than the existing literature.

Propositions 1 and 2 imply the qualitative prediction that the relative price of capital be higher in countries with lower per-capita incomes. This is consistent with the evidence reported by, among others, Jones (1994), Chari et al. (1996), Jovanovic and Rob (1997), Eaton and Kortum (2001), and Restuccia and Urrutia (2001). In our model economy, the difference in the relative prices of capital is entirely due to a lower relative price of non-tradable service goods when monopoly rights are effective. The price of domestic capital goods in terms of foreign capital goods is unaffected by monopoly rights, as capital goods are assumed to be tradable across regimes. These features are qualitatively consistent with the evidence reported by Hsieh and Klenow (2002) that, across countries, per-capita incomes are positively correlated with the price of non-tradables in terms of capital goods whereas they are uncorrelated with the price of domestic capital goods in terms of foreign (US, that is) capital goods.

4 Quantitative Results

In this section, we explore the quantitative implications of monopoly rights. We choose standard parameter values when this is possible. So, we choose $\beta = 0.96$, implying a net real rate of return on capital of about 4 percent. We choose $\gamma = 1.02$, implying that the technological frontier grows at 2 percent. This is about the long-run growth rate of the US economy, which discovers many of the inventions and innovations that can be adopted by developing countries. We choose $\delta = 0.08$, which is an upper bound on the reasonable choices because useful lives are likely to be larger in developing countries than in the US. This choice goes against us because a larger δ makes capital accumulation less important. We choose $\theta = 0.4$, which implies a capital share of forty percent. There is a debate about the value of θ for poor countries [see, for example, Boldrin and Jones (2002) and Gollin (2002)]. We therefore explore our model economy also for $\theta \in [0.3, 0.45]$.² Finally,

²Note that for lack of information, we have restricted all sectors to have equal capital shares. We will need to evaluate how reasonable that assumption is (if we knew that it was for the OECD countries or

we do not need a specific value for σ because $Y_t = Z_t$ in equilibrium; recall though that $\sigma < 1$ is assumed.

To calibrate the parameter values specific to our model economy, we use the 1996 Benchmark Study of the Penn World Tables. The advantage of this benchmark study is that it documents detailed price and quantity data for a large number of countries (115 countries to be precise). Unfortunately many of these countries are not contained in the other available benchmark studies. It is for this reason that we do not use averages across benchmark years, which we would otherwise use to calibrate the BGPs.

We start the calibration by identifying the countries with the ten percent highest per-capita incomes and the countries with the ten percent lowest per-capita incomes in the sample (both measured in ppp-adjusted international prices). In decreasing order of per-capita incomes, the richest countries are Luxembourg, Singapore, Hong Kong, Norway, USA, Switzerland, Japan, Denmark, Bermuda, Iceland, Canada; the poorest countries are Mongolia, Senegal, Nigeria, Benin, Tajikistan, Yemen, Zambia, Mali, Malawi, Madagascar, Tanzania. We find the standard result that the average per-capita income of the richest ten percent is by a factor 30.3 larger than that of the poorest ten percent.

We calibrate α as follows. α is the expenditure share of non-tradable consumption goods in total consumption expenditure measured in domestic currency. We find that across the ten percent richest and poorest countries the weighed-average α equals 0.65 (where the weigh of a country is its income divided by the sum of the incomes of the ten percent richest and poorest countries evaluated at international prices). We calibrate ω as follows. In the model economy with monopoly rights, ω determines the relative price of non-tradable services in terms of tradable manufacturing goods: $p_{xt} = (1 - \omega)^{1-\theta}$. In the model economy without monopoly rights, this relative price equals one: $p_{xt} = 1$. We compute the average relative prices for the ten percent richest and poorest countries and obtain that the ratio of the two equals 7.34.³ Assuming that the ten percent

the US, we could invoke the usual assumption that technology is uniform across the world).

³To be precise the average relative price is the weighed average of the prices of the different categories of goods. The weighs are given by the share of each category in the expenditure. As tradables we classified bread and cereal, meat, fish, milk, cheese and eggs, oil and fat, fruit, vegetables and potatoes,

poorest countries correspond to our model economy with monopoly rights and the ten percent richest countries correspond to our model economy without monopoly rights and maintaining $\theta = 0.4$, we obtain $\omega = 0.0364$.

Table 1: Quantitative results (“m” for “monopoly rights”, “n” for “no monopoly rights”)

θ	$\frac{p_x(n)}{p_x(m)}$	$\frac{TFP_z(n)}{TFP_z(m)}$	$\frac{GDP(n,p_x^*)}{GDP(m,p_x^*)}$	$\frac{\delta K(n,p_x^*)}{GDP(n,p_x^*)}$	$\frac{\delta K(m,p_x^*)}{GDP(m,p_x^*)}$	$\frac{w_i(m)}{w_o(m)}$
0.3	7.34	7.09	5.22	0.22	0.07	1.04
0.35	7.34	6.63	6.07	0.25	0.09	1.16
0.4	7.34	6.26	7.07	0.29	0.11	1.29
0.45	7.34	5.97	8.19	0.32	0.15	1.44

The quantitative results are summarized in Table 1. The first column shows that the relative price difference is a factor of 7.34, as we calibrated it to be. The next column lists the ratios of TFP in the intermediate goods sectors with and without monopoly rights, indicated by the arguments “m” and “n”. In short, TFP in the intermediate goods sectors is between five and six times higher without monopoly rights than with monopoly rights. The third column lists the ratios of the per-capita incomes with and without monopoly rights evaluated at the international price p_x^* , so, for example, $GDP(m,p_x^*) = p_x^*X(m) + Y(m)$. We construct p_x^* following the same procedure as is used in the Penn World Tables: The international price of a category of goods equals the weighed average of the dollar prices of that category in the different countries contained in the 1996 Benchmark Study; the weighs are the relative GDPs; the dollar price of a category in a country is the domestic-currency price of that category multiplied by the dollar exchange rate. We can see that monopoly rights reduce the level of per-capita income by a factor of between 5 and 8. For our calibration $\theta = 0.4$, the result is 7.07. This factor is more than twice that reported by Parente and Prescott (1999) for a model without capital accumulation. The fourth and the fifth columns list the investment shares in total output other food, non-alcoholic beverages, tobacco, clothing (including repair), fuel and power, furniture, floor covering, household goods and textiles, household appliances and repairs, and personal transportation equipment. As non-tradables we classified gross rent and water charges, medical health care, operation of transportation equipment, purchase transportation service, communication, recreation and culture, education, restaurants, cafes and hotels, and other goods and services.

without monopoly rights and with monopoly rights, evaluated at international prices. The predicted effect of monopoly rights on the investment share is roughly consistent with the data in the 1996 Benchmark Study where the ten percent richest countries have an investment share of 22 percent and the ten percent poorest of 9.65 percent, both measured in ppp-adjusted international prices. (But we will do better than that!). The last column lists the insider wage premia with monopoly rights. These premia look rather small. This is misleading though because they are expressed in units of the manufacturing good which does not change its relative price with respect to the world market price. Since services become more than seven times cheaper in the monopoly rights economy, the implied insider utility premia are large.

Our results raise the question why society grants monopoly rights to coalitions of factor suppliers at the costs of such substantial reductions in incomes. Olson (1982) argued that if the costs of granting monopoly rights to each coalition are small, then lobbying will result in monopoly rights being granted. In recent work, Bridgeman et al. (2001) have taken up this argument in a model of lobbying and technology adoption. The follow up question arises why society cannot buy out the coalitions through compensatory schemes. There are at least two answers to this question. First, Parente and Prescott (1999) argued that compensatory schemes are not practical. For example, they are not time inconsistent: Once a coalition has given up monopoly rights, society can tax away the transfers it paid to it in exchange. Second, Kocherlakota (2001) showed that limited enforcement and sufficient inequality can imply that the allocation with monopoly rights is in fact Pareto efficient, so a compensatory scheme does not exist.

5 Conclusion

We have explored the implications of monopoly rights which permit coalitions of insiders to resist the adoption of more efficient technologies. The novelty is that we have used the neoclassical growth model with tangible capital. We have found that modeling explic-

itly the interaction between monopoly rights and investment magnifies the detrimental consequences of monopoly rights on the per-capita income level. Specifically, we have demonstrated that reductions in the per-capita income level of a factor of more than 7 are possible for reasonable parameter choices. This order of magnitude is more than two times larger than that reported by Parente and Prescott (1999) for a model without capital accumulation. The mechanism behind our large income reductions is that monopoly rights in the capital-producing sector not only reduce productivity and investment there, but also increase the relative price of capital, and so reduce investment in the rest of the economy.

Several direction for future research emerge. First, we have assumed that each coalition is small relative to the aggregate economy. While that is the natural starting point, several economies (particularly in Scandinavia) have economy-wide labor coalitions. This is important because an economy-wide coalition will take into account the effects of its technology choice on aggregate variables such relative prices and the real interest rate, and should therefore block less. A challenging task for future research is to show this formally. Second, the existing evidence on monopoly rights is mainly micro-evidence showing how monopoly rights do lead to the use on inefficient technologies and working arrangements at the firm or sector level; see for example Parente and Prescott (1999,2000) and Schmitz (2001b). Our paper makes the clear prediction that the macro implications of monopoly rights should depend on where they apply. In particular, monopoly rights should be most detrimental when they largely apply to the capital-producing sectors. We plan to explore whether this prediction is confirmed by the data. Finally, we have restricted our attention to a narrow concept of capital with capital shares of up to 0.45. Chari et al. (1996) showed that broadening the concept of capital increases the income level differences that tax distortions generate. We plan to extent the present model economy by including human capital accumulation and to explore whether the same is true for monopoly rights.

References

- Acemoglu, Daron and Fabrizio Zilibotti**, “Productivity Differences,” *Quarterly Journal of Economics*, 2001, *115*, 563–606.
- Boldrin, Michele and Larry Jones**, “Mortality, Fertility, and Savings in a Malthusian Economy,” *Review of Economic Dynamics*, 2002, *5*, 775–814.
- Bridgeman, Benjamin R., Igor D. Livshits, and James C. MacGee**, “Vested Interests and Technology Adoption,” Manuscript, Federal Reserve Bank of Minnesota 2001.
- Chari, Varadarajan V., Patrick J. Kehoe, and Ellen R. McGrattan**, “The Poverty of Nations: a Quantitative Exploration,” Staff Report 204, Federal Reserve Bank of Minneapolis, Research Department 1996.
- Eaton, Jonathan and Samuel Kortum**, “Trade in Capital Goods,” *European Economic Review*, 2001, *45*, 1195–1235.
- Gollin, Douglas**, “Getting Income Shares Right,” *Journal of Political Economy*, 2002, *110*, 458–474.
- Hall, Robert and Charles I. Jones**, “Why Do Some Countries Produce So Much More Output Per Worker Than Others?,” *Quarterly Journal of Economics*, 1999, *114*, 83–116.
- Herrendorf, Berthold and Arilton Teixeira**, “How Trade Policy Affects Technology Adoption and Productivity,” Discussion Paper 3486, CEPR 2002.
- Holmes, Thomas J. and James A. Schmitz**, “Resistance to New Technology and Trade Between Areas,” *Federal Reserve Bank of Minneapolis Quarterly Review*, 1995, *19*, 2–17.
- Hsieh, Chang-Tai and Peter J. Klenow**, “Relative Prices and Relative Prosperity,” Manuscript, Federal Reserve Bank of Minneapolis 2002.

- Jones, Charles I.**, “Economic Growth and the Relative Price of Capital,” *Journal of Monetary Economics*, 1994, *34*, 359–382.
- Jovanovic, Boyan and Rafael Rob**, “Solow vs. Solow: Machine Prices and Development,” Working Paper 5871, NBER 1997.
- Klenow, Peter J. and Andres Rodriguez-Clare**, “The Neoclassical Revival in Growth Economics: Has It Gone Too Far?,” in “NBER Macroeconomics Annual,” Cambridge, MA: MIT Press, 1997, pp. 73–103.
- Kocherlakota, Narayana R.**, “Building Blocks for Barriers to Riches,” Research Department Staff Report 288, Federal Reserve Bank of Minneapolis 2001.
- Mankiw, Gregory N., David Romer, and David Weil**, “A Contribution to the Empirics of Economic Growth,” *Quarterly Journal of Economics*, 1992, *107*, 407–437.
- McGratten, Ellen R. and James A. Schmitz**, “Explaining Cross-Country Income Differences,” in John B. Taylor and Michael Woodford, eds., *Handbook of Macroeconomics*, Amsterdam: North Holland, 1999.
- McKinsey-Global-Institute**, *Unlocking Economic Growth in Russia*, McKinsey & Co., 1999.
- Mokyr, Joel**, *The Lever of Riches: Technological Creativity and Economic Progress*, Oxford University Press, 1990.
- Olson, Mancur**, *The Rise and Decline of Nations*, Yale University Press, 1982.
- Parente, Stephen L. and Edward C. Prescott**, “Changes in the Wealth of Nations,” *Federal Reserve Bank of Minneapolis Quarterly Review*, 1993, *17*, 3–16.
- **and** ———, “Monopoly Rights: a Barrier to Riches,” *American Economic Review*, 1999, *89*, 1216–33.
- **and** ———, *Barriers to Riches*, Cambridge, MA: MIT Press, 2000.

——, **Richard Rogerson, and Randall Wright**, “Homework in Development Economics: Household Production and the Wealth of Nations,” *Journal of Political Economy*, August 2000, *108*, 680–687.

Prescott, Edward C., “Needed: A Theory of Total Factor Productivity,” *International Economic Review*, 1998, *39*, 525–52.

Restuccia, Diego and Carlos Urrutia, “Relative Prices and Investment Rates,” *Journal of Monetary Economics*, 2001, *47*, 93–121.

Schmitz, James A., “Government Production of Investment Goods and Aggregate Labor Productivity,” *Journal of Monetary Economics*, 2001, *47*, 163–187.

——, “What Determines Labor Productivity?: Lessons from the Dramatic Recovery of U.S. and Canadian Iron–Ore Industries,” Research Department Staff Report 286, Federal Reserve Bank of Minneapolis 2001.

Stokey, Nancy L. and Robert E. Lucas, *Recursive Methods in Economic Dynamics*, Harvard University Press, 1989.

Appendix

First–order Conditions

Here we derive the first–order conditions. The first–order conditions to problem (1) of the representative individuals are:

$$p_{xt}x_{it} = \alpha[(1 + r_t - \delta)k_{it} + w_{it} - k_{it+1}], \quad (9a)$$

$$y_{it} = (1 - \alpha)[(1 + r_t - \delta)k_{it} + w_{it} - k_{it+1}], \quad (9b)$$

$$\frac{(x_{it})^{\alpha(1-\rho)}}{(y_{it})^{\rho+\alpha(1-\rho)}} = \beta(1 + r_{t+1} - \delta) \frac{(x_{it+1})^{\alpha(1-\rho)}}{(y_{it+1})^{\rho+\alpha(1-\rho)}}. \quad (9c)$$

The first-order conditions to problem (2) of the representative firm in the service sector are:

$$r_t = p_{xt} \theta k_{xt}^{\theta-1} \gamma^{t(1-\theta)} \left(l_{xot} + \int_1^2 l_{xit} di \right)^{1-\theta}, \quad (10a)$$

$$w_{it} \geq p_{xt} (1-\theta) k_{xt}^{\theta} \gamma^{t(1-\theta)} \left(l_{xot} + \int_1^2 l_{xit} di \right)^{-\theta}, \quad \text{“=” if } l_{xit} > 0, \quad (10b)$$

$$w_{ot} \geq p_{xt} (1-\theta) k_{xt}^{\theta} \gamma^{t(1-\theta)} \left(l_{xot} + \int_1^2 l_{xit} di \right)^{-\theta}, \quad \text{“=” if } l_{xot} > 0. \quad (10c)$$

The first-order conditions to problem (3) of the representative firm in the intermediate good sector j imply the demand functions for intermediate goods j :

$$z_{yjt} = \frac{y_t}{p_{zjt}^{\sigma}}. \quad (10d)$$

Imposing zero profits, in addition, gives:

$$1 = \int_1^2 p_{zjt}^{1-\sigma} dj. \quad (10e)$$

The first-order conditions to the problem (4) of the representative firm in the intermediate good sector j , are:

$$r_t = p_{zjt} \theta k_{zjt}^{\theta-1} [(1-\omega) \gamma^t l_{zjot} + \gamma^{\tau_{jt}} l_{zjit}]^{1-\theta}, \quad (10f)$$

$$w_{jt} \geq p_{zjt} (1-\theta) k_{zjt}^{\theta} \gamma^{\tau_{jt}} [(1-\omega) \gamma^t l_{zjot} + \gamma^{\tau_{jt}} l_{zjit}]^{-\theta}, \quad \text{“=” if } l_{xit} > 0 \quad (10g)$$

$$w_{ot} \geq p_{zjt} (1-\theta) k_{zjt}^{\theta} (1-\omega) \gamma^t [(1-\omega) \gamma^t l_{zjot} + \gamma^{\tau_{jt}} l_{zjit}]^{-\theta}, \quad \text{“=” if } l_{xot} > 0. \quad (10h)$$

Proof of Proposition of 1

We start the proof by showing that there are unique value functions and policy functions for the problems of the two representative individuals. To this end, transform the relevant variables by deflating them by their postulated growth rates along a balanced growth

path.⁴

$$\tilde{x}_{it} \equiv \frac{x_{it}}{\gamma^t}, \quad \tilde{y}_{it} \equiv \frac{y_{it}}{\gamma^t}, \quad \tilde{k}_{it} \equiv \frac{k_{it}}{\gamma^t}, \quad \tilde{F}_t \equiv F - t, \quad \text{etc.}$$

Since the frontier is now constant, we define $\tilde{S} \equiv (\tilde{T}, \tilde{K})$. We will only report the proof for the representative insider. It is very similar for the representative outsider. The indirect period utility of the representative insider can then be written as:

$$\tilde{u}(\tilde{S}, \tilde{\tau}, \tilde{k}_i, \tilde{k}'_i) = \tilde{\beta}^t \frac{\alpha^{\alpha(1-\rho)} (1-\alpha)^{\alpha(1-\rho)} \{ \tilde{w}_i(\tilde{S}, \tilde{\tau}) + [1 + \tilde{r}(\tilde{S}) - \delta] \tilde{k}_i - \gamma \tilde{k}'_i \}^{1-\rho}}{[\tilde{p}_x(\tilde{S})]^{\alpha(1-\rho)}}.$$

Using this, the Bellman equation can be written as

$$\begin{aligned} \tilde{v}_i(\tilde{S}, \tilde{\tau}, \tilde{k}_i, \tilde{k}'_i) &= \max_{0 \leq \tilde{k}'_i \leq \gamma^{-1} \{ \tilde{w}_i(\tilde{S}, \tilde{\tau}) + [1 + \tilde{r}(\tilde{S}) - \delta] \tilde{k}_i \}} \{ \tilde{u}(\tilde{S}, \tilde{\tau}, \tilde{k}_i, \tilde{k}'_i) + \tilde{\beta} \tilde{v}_i(\tilde{S}', \tilde{\tau}', \tilde{k}'_i, \tilde{k}'_i) \} \\ \text{s.t. } \tilde{S}' &= \tilde{G}(\tilde{S}), \quad (\tilde{\tau}', \tilde{\kappa}'_i) = (\tilde{q}_\tau, \tilde{q}_{\kappa_i})(\tilde{S}, \tilde{\tau}, \tilde{k}_i). \end{aligned}$$

Since there are decreasing marginal returns to capital and positive depreciation, there is some maximal sustainable capital stock, which we call \bar{K} . Define the set of possible values for the capital stock as $X \equiv [0, \max\{\tilde{K}_{i0} + \tilde{K}_{o0}, \bar{K}\}]$ and the set of possible states as $\mathcal{X} \equiv ((-\infty, 0] \times X)^2 \times X$. Furthermore, define the correspondence $\Gamma : \mathcal{X} \rightarrow \mathcal{X}$ that describes the feasibility constraints by $\Gamma(\tilde{T}, \tilde{K}, \tilde{\tau}, \tilde{k}_i) = (-\infty, 0] \times X \times (-\infty, 0] \times [0, \gamma^{-1} \{ w_i(\tilde{T}, \tilde{K}, \tilde{\tau}) + [1 + r(\tilde{T}, \tilde{K}) - \delta] \tilde{k}_o \}]^2$. \mathcal{X} and Γ so defined satisfy the assumptions of Theorems 4.6, 4.8, and 4.11 of Stokey and Lucas (1989), so there exists a unique value function and a unique policy function.

We continue with the problem of the representative insider coalition for $\omega = 0$. Note first that the complicated looking problem of the insider coalition of a sector boils down to a very simple static problem, namely the problem of maximizing the next period's utility of the representative insider of your sector. To understand that problem suppose first that the coalition chooses $\tau_t = t$. Then the outsiders and the insiders earn the same wage in intermediate goods which must equal the wage they can earn in services. Since

⁴Recall that $\iota \in \{o, i\}$.

$p_{zt} = 1$ in symmetric equilibrium, we must have $p_{xt} = 1$. This is an equilibrium because the coalition cannot increase the insider wage, which follows from two observations. First, the outsider wage is pinned down by the indifference of the outsiders between services and the intermediate good sector. Second, the outsider wage is at least as large as the insider wage in the intermediate good sector. Suppose second that the coalition chooses $\tau_t < t$. The first subcase is that the outsiders work in all sectors, which again implies that $p_{xt} = 1$. Since for $\tau_t < t$ the insider wage in the intermediate good sector is smaller than the outsider wage, the insiders must then work only in services. This is an equilibrium if the expenditure share of services is sufficiently larger (0.5 is a lower bound). The second subcase is that the outsiders work only in services. Some insiders must then work in the intermediate good sector, which leads to a contraction because the outsiders could earn a higher wage there while the services the insiders could earn the same wage as the outsiders. The third subcase is that the outsiders work only in the intermediate good sector. To see why this is impossible, we compute the insider wage in the intermediate good sector and show that the insiders would profit from lowering τ_t whatever its value may be.

To solve for the insider wage in this case, substitute (10a) into (10b) and (10f) and (10g),

$$w_{it} = (1 - \theta)p_{zt}^{\frac{1}{1-\theta}} \left(\frac{\theta}{r_t} \right)^{\frac{\theta}{1-\theta}} \gamma^{\tau_t}. \quad (11)$$

Then, combine (10d) with the production function from (4):

$$K_{zt}^{\theta} (\gamma^t + \gamma^{\tau_t} l_{zit})^{1-\theta} = Y_t p_{zt}^{-\sigma},$$

implying that

$$p_{zt} = \frac{Y_t^{\frac{1}{\sigma}}}{K_{zt}^{\frac{\theta}{\sigma}} (\gamma^t + \gamma^{\tau_t} l_{zit})^{\frac{1-\theta}{\sigma}}}. \quad (12)$$

Combining this with (10f), we find:

$$K_{zt} = \left[\frac{Y_t \theta^\sigma}{r_t^\sigma (\gamma^t + \gamma^{\tau_t} l_{zit})^{(1-\theta)(1-\sigma)}} \right]^{\frac{1}{\theta + \sigma(1-\theta)}}. \quad (13)$$

Substituting this expression back into (12) gives the relative price in terms of τ_t and of variables that are exogenous to the coalition:

$$p_{zt} = [\theta^{-\theta} Y_t^{1-\theta} r_t^\theta (\gamma^t + \gamma^{\tau_t} l_{zit})^{-(1-\theta)}]^{\frac{1}{\theta + \sigma(1-\theta)}}. \quad (14)$$

The insider wage results after substituting this expression into (11):

$$w_{it} = (1 - \theta) [\theta^{\theta(\sigma-1)} Y_t^{\theta(1-\sigma)} r_t^{\theta(1-\sigma)}]^{\frac{1}{\theta + \sigma(1-\theta)}} \frac{\gamma^{\tau_t}}{(\gamma^t + \gamma^{\tau_t} l_{zit})^{\theta + \sigma(1-\theta)}}.$$

Since $1 > \theta + \sigma(1 - \theta)$, letting τ_t go to minus infinity leads to an infinite wage even if $l_{zit} = 1$. Note that $l_{z0t} = 1$ remains the case because an infinite insider wage implies an infinite outsider wage.

In sum, the insider coalition either chooses $\tau_t = t$ and the insiders are indifferent between services and their sector or the insider coalition chooses $\tau_t < t$ and all insiders work in services. The latter can be part of an equilibrium only if α is sufficiently large so that the equilibrium quantity of services is sufficiently large. In any case, the equilibrium allocation will be independent of who works where. For the rest of the proof, we therefore do not distinguish between the different types of labor and we adopt the following convenient notation:

$$X_t = K_{xt}^\theta \gamma^{t(1-\theta)} L_{xt}^{1-\theta}, \quad Z_t = K_{zt}^\theta \gamma^{t(1-\theta)} L_{zt}^{1-\theta}.$$

Recalling the definition of variables with tildes, this implies that

$$\tilde{X}_t = \tilde{K}_{xt}^\theta L_{xt}^{1-\theta}, \quad \tilde{Z}_t = \tilde{K}_{zt}^\theta L_{zt}^{1-\theta}.$$

The next part of the proof is to show market clearing. We start by noting that equalization of the wages and the real interest rates implies that the capital–labor ratios are equalized, which, in turn, implies that $p_{xt} = 1$. This together with the Euler equations (9c) gives that along the BGP, the capital–labor ratios are given by:

$$\frac{\tilde{K}_t}{2} = \frac{\tilde{K}_{xt}}{L_{xt}} = \frac{\tilde{K}_{zt}}{L_{zt}} = \left[\frac{\beta\theta}{\gamma^\rho - \beta(1 - \delta)} \right]^{\frac{1}{1-\theta}}. \quad (15)$$

Walras law implies that we only need to prove market clearing for the y -sector. The supply of manufacturing goods for consumption is given by the production minus the BGP investment:

$$\tilde{K}_{zt}^\theta L_{zt}^{1-\theta} + (1 - \delta - \gamma)\tilde{K}_t.$$

The demand for consumption manufacturing goods is given by $1 - \alpha$ times the income that is spent on consumption goods. Recalling that without monopoly rights, $p_{xt} = 1$, we have:

$$(1 - \alpha)[\tilde{K}_{xt}^\theta L_{xt}^{1-\theta} + \tilde{K}_{zt}^\theta L_{zt}^{1-\theta} + (1 - \delta - \gamma)\tilde{K}_t].$$

Equalizing supply and demand and rearranging, we find:

$$\left(\frac{\tilde{K}_{zt}}{L_{zt}} \right)^\theta L_{zt} = (1 - \alpha) \left[\left(\frac{\tilde{K}_{xt}}{L_{xt}} \right)^\theta L_{xt} + \left(\frac{\tilde{K}_{zt}}{L_{zt}} \right)^\theta L_{zt} \right] + \alpha(\gamma + \delta - 1) \left(\frac{\tilde{K}_t}{2} \right) 2.$$

Using (15) and that $L_{xt} + L_{zt} = 2$, we obtain:

$$\frac{L_{zt}}{2} = (1 - \alpha) + \alpha(\gamma + \delta - 1) \left(\frac{\tilde{K}_t}{2} \right)^{1-\theta} = (1 - \alpha) + \alpha \frac{\beta\theta(\gamma + \delta - 1)}{\gamma^\rho - \beta(1 - \delta)}.$$

Clearly, $L_{zt} > 0$. To show that, in addition, $L_{zt} < 2$, we need to show that

$$\frac{\beta\theta(\gamma + \delta - 1)}{\gamma^\rho - \beta(1 - \delta)} < 1.$$

This is equivalent to

$$\beta(1 - \delta)(1 - \theta) < \gamma^\rho(1 - \theta\beta\gamma^{1-\rho}).$$

Since we required that $\beta\gamma^{1-\rho} < 1$ and since $\beta(1 - \delta) < \gamma^\rho$, this inequality holds always.

The final part of the proof is to show the existence of a unique BGP. This follows immediately from Theorem 4.6 of Stokey and Lucas (1989). Along the BGP, $\tilde{K}'_x = \tilde{K}_x$ and $\tilde{K}'_z = \tilde{K}_z$, so the two capital stocks grow at rate $\gamma - 1$. Given that from the previous proposition τ_t also grows at rate $\gamma - 1$, it follows that the quantities of all goods grow at rate $\gamma - 1$ too.

Proof of Proposition 2

The first part of the proof is to show that there is a value function and a policy function to the problems of the representative outsider and the representative insider. This part of the proof is exactly the same with and without monopoly rights, so it is omitted here.

The second part of the proof is to show market clearing under the assumption that the insiders work in their intermediate good sector and τ_t is such that the outsiders are just indifferent between working in services and in their intermediate good sector. So, the real returns on capital and on outsider labor need to be equalized across sectors:⁵

$$p_{xt}\theta\tilde{K}_{xt}^{\theta-1} = \theta\tilde{K}_{zt}^{\theta-1}\gamma^{(\tau_t-t)(1-\theta)}, \quad (16a)$$

$$p_{xt}(1 - \theta)\tilde{K}_{xt}^\theta = (1 - \theta)\tilde{K}_{zt}^\theta(1 - \omega)\gamma^{(\tau_t-t)(-\theta)}, \quad (16b)$$

implying

$$\frac{\tilde{K}_{xt}}{\tilde{K}_{zt}} = (1 - \omega)\gamma^{t-\tau_t}. \quad (17)$$

Putting this equation back into (16), we obtain:

$$p_{xt} = (1 - \omega)^{1-\theta}. \quad (18)$$

⁵Tildes again denote variables deflated by γ^t .

Comparing this relative price with the previous one, we can see that the relative price of services is smaller with than without monopoly rights. Using (17), (18), and the BGP conditions that the marginal products of the capital stocks in terms of the z good are given by $\gamma^\rho \beta^{-1} - 1 + \delta$, we get the two BGP capital stocks:

$$\tilde{K}_{xt} = (1 - \omega) \left[\frac{\beta\theta}{\gamma^\rho - \beta(1 - \delta)} \right]^{\frac{1}{1-\theta}}, \quad (19a)$$

$$\tilde{K}_{zt} = \gamma^{\tau_t - t} \left[\frac{\beta\theta}{\gamma^\rho - \beta(1 - \delta)} \right]^{\frac{1}{1-\theta}}. \quad (19b)$$

Comparing these two expressions with those in (15), we can see that both capital-labor ratios are smaller than without monopoly rights. Given that productivity in the intermediate good sector is also smaller (compare the previous proposition), this implies that the levels of the per capita production of the intermediate goods sectors are smaller too. If $\alpha > 0.5$, then we know more. In particular, without monopoly rights, more than half of the labor is allocated to services, whereas with monopoly rights, exactly half of the labor is allocated to services. Thus, we also know that the production of the service sector must fall (both labor and the capital-labor ratio falls).

Due to Walras law, it is enough to prove market clearing for the y -sector. In period t , the supply of manufacturing goods equals the total production plus the capital stock after depreciation minus the capital stock for next period. Along a BGP with growth rate γ , this is given by

$$\tilde{K}_{zt}^\theta \gamma^{(\tau_t - t)(1-\theta)} + (1 - \delta - \gamma)\tilde{K}_t.$$

In period t , the representative outsider and the representative insider spend a share $1 - \alpha$ of their disposable income on the manufacturing good. Using that the wage of the outsiders in the service sector equals their marginal product in the intermediate goods sectors, we obtain the consumption demand for manufacturing goods in period t :

$$(1 - \alpha) \{ (1 - \theta) \tilde{K}_{zt}^\theta [(1 - \omega) \gamma^{(\tau_t - t)(-\theta)} + \gamma^{(\tau_t - t)(1-\theta)}] + \theta \tilde{K}_{zt}^{\theta-1} \gamma^{(\tau_t - t)(1-\theta)} \tilde{K}_t + (1 - \delta - \gamma) \tilde{K}_t \},$$

where we have used the fact that in equilibrium $Y_t = Z_t$. Then, equalize supply and demand and rearrange so as to find that the market for the manufacturing goods clears if and only if

$$\alpha\beta\theta(\gamma + \delta - 1)[1 + (1 - \omega)\gamma^{t-\tau_t}] = [\alpha - (1 - \alpha)(1 - \omega)\gamma^{t-\tau_t}][\gamma^p - \beta(1 - \delta)]. \quad (20)$$

Condition (8a) from Assumption 1 in the text ensures that the left-hand side is smaller than the right-hand side when $\tau_t = t$; Condition (8b) from Assumption 1 in the text ensures that the left-hand side is larger than the right-hand side when τ_t is such that $(1 - \omega)\gamma^{t-\tau_t} = 1$. Thus, the τ_t that clears the market satisfies $(1 - \omega) < \gamma^{\tau_t - t}$, implying that the insiders will strictly prefer to work in the intermediate good sector. The uniqueness of τ_t follows because both sides (20) change monotonically and in opposite directions with τ_t .

The third part of the proof is to show that choosing τ_t such that the outsiders are just indifferent is the unique equilibrium strategy for the representative insider coalition. Substituting (10f) into (10g), we obtain the reduced forms for the wages:

$$w_{ot} = (1 - \theta)p_{xt}^{\frac{1}{1-\theta}} \left(\frac{\theta}{r_t}\right)^{\frac{\theta}{1-\theta}} \gamma^t, \quad (21a)$$

$$w_{it} = (1 - \theta)p_{zt}^{\frac{1}{1-\theta}} \left(\frac{\theta}{r_t}\right)^{\frac{\theta}{1-\theta}} \gamma^{\tau_t}. \quad (21b)$$

If the outsiders work in the intermediate good sector, then they can earn:

$$(1 - \theta)p_{zt}^{\frac{1}{1-\theta}} \left(\frac{\theta}{r_t}\right)^{\frac{\theta}{1-\theta}} (1 - \omega)\gamma^t. \quad (21c)$$

If the outsiders are indifferent, then the coalition wants to choose τ_t as large as possible. This follows because equalizing (21a) and (21c) implies

$$p_{zt} = \frac{p_{xt}}{(1 - \omega)^{1-\theta}}.$$

In other words, the relative price is given to the coalition when the outsiders are indifferent. Call $\underline{\tau}_t$ the largest such τ_t . Recall that we showed in the market clearing part of the proof above that $\underline{\tau}_t < t$ if the outsiders are indifferent. Moreover, we showed that $\gamma^{\underline{\tau}_t - t} > 1 - \omega$, so we know that for $\tau_t > \underline{\tau}_t$, the insiders still prefer manufacturing and the outsiders now prefer services. To solve for the insider wage in this case, combine (10d) with the production function from (4):

$$K_{zt}^\theta \gamma^{\tau_t(1-\theta)} = Y_t p_{zt}^{-\sigma},$$

implying that

$$p_{zt} = \frac{Y_t^{\frac{1}{\sigma}}}{K_{zt}^{\frac{\theta}{\sigma}} \gamma^{\frac{\tau_t(1-\theta)}{\sigma}}}. \quad (22)$$

Combining this with (10f), we find:

$$K_{zt} = \left[\frac{Y_t \theta^\sigma}{r_t^\sigma \gamma^{\tau_t(1-\theta)(1-\sigma)}} \right]^{\frac{1}{\theta + \sigma(1-\theta)}}. \quad (23)$$

Substituting this expression back into (22) gives the relative price in terms of τ_t and of variables that are exogenous to the coalition:

$$p_{zt} = [\theta^{-\theta} Y_t^{1-\theta} r_t^\theta \gamma^{-\tau_t(1-\theta)}]^{\frac{1}{\theta + \sigma(1-\theta)}}. \quad (24)$$

The insider wage results after substituting (24) into (21b):

$$w_{it} = (1 - \theta) [\theta^{\theta(\sigma-1)} Y_t r_t^{\theta(1-\sigma)}]^{\frac{1}{\theta + \sigma(1-\theta)}} \gamma^{-\frac{(1-\theta)(1-\sigma)}{\theta + \sigma(1-\theta)} \tau_t}. \quad (25)$$

Our assumption that $\sigma < 1$ implies that the insider wage increases when $\tau_t \in (\underline{\tau}_t, t]$ decreases. So for $\tau_t \in [\underline{\tau}_t, t]$ it is optimal to choose $\tau_t = \underline{\tau}_t$.

The last part of the proof is to show that no other equilibrium than the one just characterized can exist. Suppose that $\tilde{\tau}_t > \underline{\tau}_t$ is part of an equilibrium. There are three possible cases. First, if the insiders preferred to work in their intermediate good sector

and the outsiders preferred to work in services, then the insiders could increase their wage by decreasing τ_t ; compare (25). Second, if the insiders preferred to work in services and the outsiders preferred to work in intermediate goods, then we would have

$$\gamma^{\tilde{\tau}_t - t} < p_{xt}^{\frac{1}{1-\theta}} < 1 - \omega.$$

Thus, the production in the intermediate good sector would be more efficient than before while the service good would be cheaper than before. That is inconsistent with market clearing. Third, if the insiders were indifferent, there would be three subcases. If the outsiders were indifferent too, we would be in the equilibrium characterized before. If the outsiders strictly preferred services, then (25) would apply and the coalition of insiders could increase their real wage in their intermediate goods sector by lowering τ_t . If the outsider strictly preferred intermediate goods, then a modified version of (25) would apply:

$$w_{it} = (1 - \theta) [\theta^{\theta(\sigma-1)} Y_t r_t^{\theta(1-\sigma)}]^{\frac{1}{\theta+\sigma(1-\theta)}} \frac{\gamma^{\tau_t}}{[(1 - \omega)\gamma^t + \gamma^{\tau_t}]^{\frac{1}{\theta+\sigma(1-\theta)}}}.$$

Since $1 > \theta + \sigma(1 - \theta)$, letting τ_t go to minus infinity leads to an infinite wage.