

Monopoly Rights Can Reduce Income Big Time*

Berthold Herrendorf[†]

Universidad Carlos III de Madrid, University of Southampton, CEPR

Arlton Teixeira[‡]

Ibmec

February 26, 2003

Abstract

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 the capital stock and the production fall in *each* sector. We finally show that the implied fall in the level of per-capita income can be large quantitatively.

Keywords: capital accumulation; monopoly rights; technology adoption; total factor productivity; vested interests.

JEL classification: E00; E04.

*We are grateful to Edward Prescott and James Schmitz for their continuous help and encouragement and to Peter Klenow for sharing his price data with us. We have profited from comments and suggestions by Michele Boldrin, Juan Carlos Conesa, Antonia Díaz, Thomas Holmes, Juan Ruiz, Michele Tertilt, Ákos Valentinyi, and the audiences of the European Forum in Maastricht, the Madrid Macro Seminar (Mad-Mac), the Thanksgiving Conference in Essex, and the University of Barcelona. Herrendorf acknowledges research funding from the Spanish Dirección General de Investigación (Grant BEC2000-0170), from the European Union (Project 721, “New Approaches in the Study of Economic Fluctuations”), and from the Instituto Flores Lemus (Universidad Carlos III de Madrid).

[†]Address: Universidad Carlos III de Madrid, Departamento de Economía, Calle Madrid, 126, 28903 Getafe (Madrid), Spain. Email: herrendo@eco.uc3m.es.

[‡]Address: Ibmec, Department of Economics, Av. Rio Branco, 108/12o. andar, Rio de Janeiro, RJ, 20040-001, Brazil. Email: arilton@ibmecrj.br.

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 large income level difference without contradicting the growth facts. Since differences in total factor productivity play an important role, a successful theory needs to be also a theory of large cross-country differences in TFP [Klenow and Rodriguez-Clare (1997) and Prescott (1998)]. One possible explanation is that a substantial part of 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), and Parente and Prescott (1999,2000).

Here we explore the quantitative implications of monopoly rights. Our main innovation compared to the existing literature is to embed monopoly rights into 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 having capital magnifies the effect of monopoly rights 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 a sector form a coalition that chooses the marginal product of insider labor. We assume that the insiders either do not have monopoly rights or they do have monopoly rights. If the insiders do not have monopoly rights the outsiders can work in that sector without restrictions. Outsider labor then is as productive as insider labor when the frontier technology is used, implying that the insiders face unrestricted competition from the outsiders. If the insiders of an intermediate good sector do have monopoly rights, then the outsiders can work in that sector only with restrictions. Insider labor is then more productive than outsider labor when the frontier technology is used, implying that the insiders face only restricted competition from the outsiders.

We derive several analytical results. (i) When they have monopoly rights the coalitions of insiders choose inefficient technologies; when they do not have monopoly rights, they choose the frontier technology. (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 stocks 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. 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.

Why do the insider coalitions find it optimal to choose inefficient technologies? Here,

each coalition is small relative to the aggregate economy, so it cannot affect any relative price except for that of its intermediate good. Assuming that the demand for intermediate goods is inelastic, the choice of an inefficient technology increases the relative price by more than it decreases the marginal product of the insiders, so it increases the insiders' real income. The extent to which they can increase their real income is limited by the possibility that the outsiders enter the intermediate good 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, the equilibrium choice of technology is 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 first point to note is that the equilibrium price of intermediate goods in terms of domestic manufacturing goods must be equal to one. The second point is that we do not have barriers to the international trade of the manufacturing good, so its price in terms of the foreign manufacturing goods must equal one too. A decrease in the relative price of the service good in terms of the domestic manufacturing good can then come only from a decrease in the relative price of the domestic service good. This is possible because the service good is not tradable.

We derive the following quantitative results. Given plausible parameter values, monopoly rights lead to a substantial decrease in the level of per-capita income. Specifically, calibrating our model economy to the 1996 Benchmark Study of the Penn World Tables, we find that monopoly rights can explain per-capita income differences of a factor 6.4. This difference amounts to about 36 percent of the observed difference between the average per-capita income levels of the ten percent richest and the ten percent poorest countries in the 1996 Benchmark Study. Moreover, it is more than twice as big as the difference of a 2.7 found by Parente and Prescott (1999) for a model economy without capital.

Interestingly, we obtain such sizable income differences with a narrow concept of tangible capital with capital shares that are empirically plausible [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.

Why do monopoly rights generate such substantial reductions in the per-capita income of our model economy? The novelty here is that monopoly rights reduce the productions of *all* sectors, not just of the intermediate good sectors. The reductions in the intermediate good productions, and thus in manufacturing, come from a direct and an indirect effect: monopoly rights reduce productivity in the intermediate good sectors, which reduces production and the capital stocks. The reduction in the service production comes from an indirect effect: monopoly rights decrease the relative price of services in terms of capital goods, making investment purchases more expensive for firms in the service sector. That reduces the capital stock in the service sector. Capital therefore provides an amplification mechanism that spreads the negative effects of monopoly rights to the competitive sectors.

2 Model Economy

2.1 Environment

There is a measure one of identical outsiders and measures one of identical insiders of type i for all $i \in [1, 2]$. 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. The prob-

lem of the representative outsider is:

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

$$x_{ot}, y_{ot}, k_{ot+1} \geq 0, \quad k_{o0} > 0 \text{ given.}$$

The utility function has the standard functional form

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

We have used the following notation. $\beta \in (0, 1)$ is the discount factor; the subscript o stands for outsider; $\alpha \in (0, 1)$ is the expenditure share of x_{ot} ; $\rho \in [0, \infty)$ is the intertemporal elasticity of substitution; p_{xt} is the price of x_t in terms of the numeraire y_t ; k_{ot+1} is the capital stock for period $t + 1$ and k_{ot} is the installed capital stock held by the representative outsider in period t ; w_{ot} and r_t are the outsider wage and the real rental rate of installed capital, both expressed in terms of the numeraire y_t ; $\delta \in [0, 1]$ is the depreciation rate of installed capital. The problem of the representative insider of type i , $i \in [1, 2]$, is similar:

$$\max_{\{x_{it}, y_{it}, k_{it+1}\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t u(x_{it}, y_{it}) \quad \text{s.t.} \quad p_{xt}x_{it} + y_{it} + k_{it+1} = (1 + r_t - \delta)k_{it} + w_{it}, \quad (2)$$

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

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

$$\max_{x_t, k_{xt}, l_{xt}} (p_{xt}x_t - r_t k_{xt} - w_{ot} l_{xt}) \quad \text{s.t.} \quad x_t = k_{xt}^\theta (\gamma^t l_{xt})^{1-\theta}, \quad x_t, k_{xt}, l_{xt} \geq 0, \quad (3)$$

where $\theta \in (0, 1)$ is the capital share, $\gamma - 1 \in [0, \infty)$ is the exogenous growth rate of labor–

augmenting technical progress, and k_{xt} and l_{xt} are the inputs of capital and outsider labor. The representative firm in the manufacturing sector faces the following sequence of static problems:

$$\max_{y_t, z_{yjt}} \left(y_t - \int_1^2 p_{zjt} z_{yjt} dj \right) \quad \text{s.t.} \quad y_t = \left(\int_1^2 z_{yjt}^{\frac{\sigma-1}{\sigma}} dj \right)^{\frac{\sigma}{\sigma-1}}, \quad y_t, z_{yjt} \geq 0, \quad (4)$$

where p_{zjt} is the price of intermediate good z_{jt} in terms of the numeraire y_t , z_{yjt} is the input of the j -th intermediate good, and $\sigma \in (0, 1)$ is the elasticity of substitution between any two intermediate goods. As in Parente and Prescott (1999), our results require 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 grouping goods appropriately (Volkswagen cars versus Mercedes cars or cars versus bicycles). The representative firm in the j -th intermediate good sector faces the following sequence of static problems:

$$\max_{z_{jt}, k_{zjt}, l_{zjot}, l_{zjit}} (p_{zjt} z_{jt} - r_t k_{zjt} - w_{ot} l_{zjot} - w_{jt} l_{zjit}) \quad (5)$$

$$\text{s.t.} \quad z_{jt} = k_{zjt}^\theta [(1 - \omega) \gamma^t l_{zjot} + \gamma^{\tau_{jt}} l_{zjit}]^{1-\theta}, \quad z_{jt}, k_{zjt}, l_{zjot}, l_{zjit} \geq 0,$$

where w_{jt} is the wage for insiders of sector j . The exogenous parameter $\omega \in [0, 1)$ is a measure of how strong the monopoly rights are: $\omega = 0$ corresponds to “no monopoly rights” and $\omega > 0$ corresponds to “monopoly rights”. The value of τ_{jt} is determined in period $t - 1$ at the same time when all 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 their 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 good sectors and in the service sector.

We experimented with two alternatives to the production function of sector j . The

first alternative has outsiders and insiders produce with different capital stocks:

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

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 alternative does not make a difference for our results, so choosing our specification is merely a matter of carrying a little less notation. The second alternative has the coalition choose not only its own productivity but also that of the outsiders:

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

This would be the case if the insiders had more monopoly power than in our specification. We found that the BGP with monopoly rights then becomes indeterminate, so we prefer our specification.

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. Denoting aggregate variables by upper-case letters the market clearing conditions are:

$$X_t = X_{ot} + \int_1^2 X_{it} di, \quad (6a)$$

$$Y_t + Y_t^* + (1 - \delta) \left(K_{ot} + \int_1^2 K_{it} di \right) = (Y_{ot} + K_{ot+1}) + \int_1^2 (Y_{it} + K_{it+1}) di, \quad (6b)$$

$$Z_{jt} = Z_{yjt}, \quad (6c)$$

$$K_{ot} + \int_1^2 K_{it} di = K_{xt} + \int_1^2 K_{zjt} dj, \quad (6d)$$

$$L_{xt} = 2 - \int_1^2 (L_{z_{jot}} + L_{z_{jit}}) dj. \quad (6e)$$

The first two market clearing conditions require that the markets for final goods clear, where Y_t^* denotes the imports of Y_t . The next market clearing condition requires that

the markets for intermediate goods clear. The last two market clearing conditions require that the factor markets clear.

Our model economy abstracts from borrowing between insiders and outsiders and between domestic and foreign individuals. This is without loss of generality because we will only consider balanced growth paths. Without borrowing and lending between domestic and foreign individuals, international trade is balanced in each period: $Y_t^* = 0$. So, in our model economy, the only implication of international trade is to fix the relative price between domestic and foreign manufacturing goods at one.

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, it does not have strategic power on the aggregate. This will considerably simplify matters. We restrict our attention to equilibria that have the following properties: they are symmetric with respect to each type of individual and to the intermediate good sectors; they are recursive in that in each period it is sufficient that the decision makers know the aggregate state and their own state.

We start the equilibrium definition by specifying the relevant state variables. As before, we denote the individual states by lower-case letters and aggregate states by upper case letters. In period t the aggregate state variable is given by the aggregate capital stock, the aggregate technology parameter, and the technology frontier: $\mathcal{S} \equiv (K, \mathcal{T}, t)$. The states of the individuals and the coalition are given by the aggregate state plus the relevant individual state: (\mathcal{S}, k_o) and (\mathcal{S}, k_i, τ) . To avoid confusion, note that since we look at a symmetric equilibrium, we have dropped the index indicating the intermediate good sector, so the states \mathcal{T} and τ are numbers, not vectors. We will also drop the time index

We now rewrite the dynamic problems in recursive form. The problems of the three

representative firms are static and straightforward to solve, so we do not repeat them here. The problem of the representative outsider is dynamic. Using his value function, v_o , we can write it as:

$$v_o(\mathcal{S}, k_o) = \max_{x_o, y_o, k'_o \geq 0} \{u(x_o, y_o) + \beta v_o(\mathcal{S}', k'_o)\} \quad (7)$$

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

where the aggregate law of motion is given by:

$$\mathcal{S}' = G(\mathcal{S}) = (G_k, G_\tau, G_3)(\mathcal{S}).$$

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

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

The problem of the representative insider differs from that of the representative outsider in that the insider's wage (in units of the numeraire) depends on the state of technology in his sector:

$$v_i(\mathcal{S}, k_i, \tau) = \max_{x_i, y_i, k'_i \geq 0} \{u(x_i, y_i) + \beta v_i(\mathcal{S}', k'_i, \tau')\} \quad (8)$$

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

$$\mathcal{S}' = G(\mathcal{S}), \quad \tau' = g_{\tau c}(\mathcal{S}, k_i, \tau),$$

where $g_{\tau c}$ is the policy function of the representative insider coalition. The solution to the insider's problem implies the policy function

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

The problem of the representative coalition is:

$$v_c(\mathcal{S}, k_i, \tau) = \max_{\tau' \in (-\infty, G_3(\mathcal{S})]} \{u(x_i, y_i) + \beta v_c(\mathcal{S}', k'_i, \tau')\} \quad (9)$$

$$s.t. \quad \mathcal{S}' = G(\mathcal{S}), \quad (x_i, y_i, k'_i) = (g_{xi}, g_{yi}, g_{ki})(\mathcal{S}, k_i, \tau).$$

A solution to the problem of the representative coalition implies the policy function $\tau' = g_{\tau c}(\mathcal{S}, k_i, \tau)$.

Definition 1 (Equilibrium) *An equilibrium is*

- (i) *price functions* $(p_x, p_z, w_o, r)(\mathcal{S}), w_i(\mathcal{S}, \tau)$;
- (ii) *allocation functions for the three types of firms*, $(x, k_x, l_x)(\mathcal{S}), (y, z_y)(\mathcal{S}), (z, k_z, l_{zo}, l_{zi})(\mathcal{S}, \tau)$,
- (iii) *aggregate laws of motion* $\mathcal{S}' = (G_k, G_\tau, G_3)(\mathcal{S})$;
- (iv) *value functions* $v_o(\mathcal{S}, k_o), v_i(\mathcal{S}, k_i, \tau), v_c(\mathcal{S}, k_i, \tau)$;
- (v) *policy functions* $k'_o = g_{ko}(\mathcal{S}, k_o), k'_i = g_{ki}(\mathcal{S}, k_i, \tau), \tau' = g_{\tau c}(\mathcal{S}, k_i, \tau)$,

such that:

- 1) *given the realizations of prices, the firms' allocations solve their problems;*
- 2) *the value functions* v_o, v_i, v_c *satisfy the Bellman equations as stated in (7), (8), (9);*
- 3) *the problems of the representative outsider, the insider, and the coalition, (7), (8), and (9), are solved by their policy functions;*
- 4) *the policy functions are consistent with the laws of motion:*

$$G_k(\mathcal{S}) = g_{ko}(\mathcal{S}, k_o) + g_{ki}(\mathcal{S}, k_i, T), \quad G_\tau(\mathcal{S}) = g_{\tau c}(\mathcal{S}, K, T);$$

- 5) *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. For the formal analysis we need to ensure that the growth rates of the technological frontiers are not too large relative to the discount factor (otherwise the individual objective functions would become infinite) and that a BGP without monopoly rights exists. The next assumptions serve this purpose.

Assumption 1 $\tilde{\beta} \equiv \beta\gamma \in (0, 1)$.

Assumption 2

$$0 < (1 - \alpha)(1 - \theta) + [(1 - \alpha)\theta + \delta + \gamma - 1] \frac{\beta\theta}{\gamma^\rho - \beta(1 - \delta)} < \frac{1}{2}.$$

Proposition 1 (BGP Without Monopoly Rights) *Suppose that $\omega = 0$ and that Assumptions 1 and 2 hold. Then there is a unique BGP equilibrium in which the most efficient technology is adopted. Along this BGP equilibrium, $p_{xt} = 1$; the technology parameter, the capital stocks, the productions of all goods grow at rate $\gamma - 1$.*

Proof. See Appendix B.

Note that the BGP equilibrium is only unique subject to the constraint that the best technology be adopted. In fact, any technology choice is an equilibrium because the insiders can work in services at the maximum wage that they may earn in intermediate goods, so choosing inefficient technologies has no consequences when all insiders work in services. These equilibria are not interesting or plausible, so we will not consider them.

To ensure the existence of a BGP equilibrium without monopoly rights, we need two further restrictions on the parameter values of the model economy:

Assumption 3

$$\alpha\beta\theta(\gamma + \delta - 1)(2 - \omega) < [\alpha - (1 - \alpha)(1 - \omega)][\gamma^\rho - \beta(1 - \delta)], \quad (10a)$$

$$2\alpha\beta\theta(\gamma + \delta - 1) > (2\alpha - 1)[\gamma^\rho - \beta(1 - \delta)]. \quad (10b)$$

Proposition 2 (BGP With Monopoly Rights) *Suppose $\omega > 0$ and Assumptions 1 and 3 hold. Then there is a unique BGP equilibrium. Along the BGP equilibrium, inefficient technologies are used: $t - \tau_t > 0$ and constant; $p_{xt} < 1$; the capital stocks and the productions of all goods grow at rate $\gamma - 1$; the outsiders work only in the service sector and the insiders work only in their intermediate good sector; the capital stocks and the quantities of all goods are smaller than without monopoly rights.*

Proof. See Appendix B.

It is optimal for the representative insider coalition to choose inefficient technologies because this increases the insiders' real wage. We show in Appendix B that the highest insider wage is obtained exactly when the technology is so inefficient that the outsiders are just indifferent between working in services and in the intermediate good sector. If efficiency increased relative to that value, then the insider wage would fall. The reason is that the demand for each intermediate good is inelastic here, so the decreases in the relative price would dominate the increase in the marginal insider productivity. If efficiency decreased relative to the above value, then the wage would fall too. The reason now is that the outsiders would remain indifferent, so the relative price would remain the same and a decrease in the marginal insider productivity would be the only effect on the insider wage.

An important implication of Proposition 2 is that having monopoly rights in the intermediate good sectors reduces the capital stocks of *all* sectors. The reason can most easily be seen by noting that 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

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

So, the direct effect of monopoly rights is to decrease productivity in the intermediate good sectors, $\tau_t < t$. This decreases the capital stocks in the intermediate good sectors. 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 stock 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. In the next section, we will see that this amplification mechanism generates big reductions in per-capita income.

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, 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 by how much monopoly rights reduce the productivity in the capital-producing sectors, the per-capita capital stocks, and per-capita income.¹ We choose standard values for β , γ , δ , and θ . Recall that $\sigma < 1$ is also assumed, but we

¹Recall that per capita variables are economy-wide, per-worker averages.

do not need a specific value for σ . In particular, 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 where many of the inventions and innovations that can be adopted by other countries take place. 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 right choice of θ for developing countries [see for example Boldrin and Jones (2002) and Gollin (2002)]. We therefore explore our model economy also for $\theta \in [0.3, 0.45]$. Note that we have imposed 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 the US, we could invoke the usual assumption that technology is uniform across the world).

To calibrate the rest of the parameters of the model economy, we use the 1996 Benchmark Study of the Penn World Tables. This benchmark study is unusually large in that it documents detailed price and quantity data for 115 countries. We start by identifying the ten percent countries with the highest per-capita incomes and the ten percent countries with the lowest per-capita incomes in the sample (both measured in ppp-adjusted international prices). We find that the average per-capita income of the richest ten percent is by a factor 17.73 larger than that of the poorest ten percent. Next, we calibrate α and ω . We interpret α to be 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 average α equals 0.65. To calibrate ω , we note that in the model economy with monopoly rights, ω determines the relative price of services in terms of 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 both groups and obtain that the ratio of the average relative prices in the ten percent richest and poorest countries equals 7.34. Assuming that the ten percent

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	$\frac{p_x(n)}{p_x(m)}$	$\frac{TFP_z(n)}{TFP_z(m)}$	$\frac{GDP(n, p_x(n))}{GDP(m, p_x(n))}$	$\frac{\delta K(n, p_x(n))}{GDP(n, p_x(n))}$	$\frac{\delta K(m, p_x(n))}{GDP(m, p_x(n))}$	$\frac{w_i(m)}{w_o(m)}$
0.3	7.34	7.09	4.10	0.17	0.04	1.04
0.35	7.34	6.63	5.03	0.20	0.05	1.16
0.4	7.34	6.26	6.39	0.23	0.06	1.29
0.45	7.34	5.97	8.48	0.25	0.07	1.44

The quantitative results are summarized in Table 1. The first column shows that the relative price difference is 7.34, as we calibrated it to be. The next column lists the ratios of TFP in the intermediate good sector with and without monopoly rights, indicated by the arguments “m” and “n”. In short, TFP in the intermediate good sectors is at least 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 international prices, so, for example, $GDP(m, p_x(n)) = p_x(n)X(m) + Y(m)$. Note that here we equate international prices with the relative prices without monopoly rights. This is justified approximately (international prices are very close to prices in Belgium, which is the 12-th richest country in our sample). We can see that monopoly rights reduce the level of per-capita income by between a factor of four and a factor of eight. For our calibration $\theta = 0.4$, the result is 6.39. The fourth and the fifth columns list the investment shares in total output without monopoly rights and with monopoly rights, evaluated at international prices. So, for example,

$$\frac{\delta K(m, p_x(n))}{GDP(m, p_x(n))} = \frac{\delta p_x(n)K(m)}{p_x(n)X(m) + Y(m)}.$$

The predicted effect that of monopoly rights on the investment share is broadly consistent with the data in our sample: 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). The last column lists the insider wage premium with monopoly rights.

5 Conclusion

We have explored the implications of monopoly rights which put coalitions of insiders into the position to resist the adoption of efficient technologies. Our innovation is to have done so within the neoclassical growth model with tangible capital. We have found that modeling explicitly the interaction between such 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 more than a factor of 6 are possible for reasonable parameter choices. This order of magnitude is more than twice as large 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 they also increase the relative price of capital and so reduce investment in the rest of the economy.

Our paper is placed within 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 study the implications of monopoly rights but abstract from capital accumulation. Further contributions to this literature study different aspects: Mankiw et al. (1992) emphasize the role of intangible capital; Chari et al. (1996), Jovanovic and Rob (1997), Eaton and Kortum (2001), and Restuccia and Urrutia (2001) emphasize the role of policy distortions that increase the relative price of capital; Parente et al. (2000) emphasize the role of home production; Acemoglu and

Zilibotti (2001) emphasize the role of skill mismatch. We view intangible capital, policy distortions, home production, and skill mismatch as alternative explanations of TFP differences that are complementary to our's. Our results suggest, however, that monopoly rights are a key part of the story.

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Appendix A: First-order Conditions

We start with the individuals. The first-order conditions to problem (1) of the representative outsider are:

$$p_{xt}x_{ot} = \alpha[(1 + r_t - \delta)k_{ot} + w_{ot} - k_{ot+1}], \quad (11a)$$

$$y_{ot} = (1 - \alpha)[(1 + r_t - \delta)k_{ot} + w_{ot} - k_{ot+1}], \quad (11b)$$

$$\frac{(x_{ot})^{\alpha(1-\rho)}}{(y_{ot})^{\rho+\alpha(1-\rho)}} = \beta(1 + r_{t+1} - \delta) \frac{(x_{ot+1})^{\alpha(1-\rho)}}{(y_{ot+1})^{\rho+\alpha(1-\rho)}}. \quad (11c)$$

The first-order conditions to problem (2) of the representative insider are:

$$p_{xt}x_{it} = \alpha[(1 + r_t - \delta)k_{it} + w_{it} - k_{it+1}], \quad (11d)$$

$$y_{it} = (1 - \alpha)[(1 + r_t - \delta)k_{it} + w_{it} - k_{it+1}], \quad (11e)$$

$$\frac{(x_{it})^{\alpha(1-\rho)}}{(y_{it})^{\rho+\alpha(1-\rho)}} = \beta(1 + r_{t+1} - \delta) \frac{(x_{it+1})^{\alpha(1-\rho)}}{(y_{it+1})^{\rho+\alpha(1-\rho)}}. \quad (11f)$$

We continue with the firms. The first-order conditions to problem (3) of the representative firm in the service sector are:

$$r_t = p_{xt}\theta k_{xt}^{\theta-1}(\gamma^t l_{xt})^{1-\theta}, \quad (12a)$$

$$w_{ot} = p_{xt}(1 - \theta)k_{xt}^{\theta}\gamma^{t(1-\theta)}l_{xt}^{-\theta}. \quad (12b)$$

The first-order conditions to problem (4) of the representative firm in the intermediate good sector j imply the demand functions for intermediate goods j :

$$z_{yjt} = \frac{y_t}{p_{zjt}^{\sigma}}. \quad (12c)$$

Imposing zero profits, in addition, gives:

$$1 = \int_1^2 p_{zjt}^{1-\sigma} dj. \quad (12d)$$

The first-order conditions to the problem (5) of the representative firm in the intermediate good sector j , are:

$$r_t = p_{zjt} \theta k_{zjt}^{\theta-1} (\omega \gamma^t l_{zjot} + \gamma^{\tau_{jt}} l_{zjit})^{1-\theta}, \quad (12e)$$

$$w_{jt} = p_{zjt} (1 - \theta) k_{zjt}^{\theta} \gamma^{\tau_{jt}} (\omega \gamma^t l_{zjot} + \gamma^{\tau_{jt}} l_{zjit})^{-\theta}, \quad (12f)$$

$$w_{ot} \geq \omega \gamma^{t-\tau_{jt}} w_{jt}. \quad (12g)$$

Appendix B: Proofs

Proof of Proposition of 1

We start the proof by showing that there is a unique value function and a unique policy function for the outsiders. (We omit the proof for the insiders because it is analogous.) To this end, transform the relevant variables by deflating them by their postulated growth rates along a balanced growth path:

$$\tilde{\mathcal{T}}_t \equiv \mathcal{T}_t - t, \quad \tilde{x}_{ot} \equiv \frac{x_{ot}}{\gamma^t}, \quad \tilde{y}_{ot} \equiv \frac{y_{ot}}{\gamma^t}, \quad \tilde{k}_{ot} \equiv \frac{k_{ot}}{\gamma^t}, \quad \tilde{K}_{xt} \equiv \frac{K_{xt}}{\gamma^t}, \quad \tilde{K}_{zt} \equiv \frac{K_{zt}}{\gamma^t}, \quad \tilde{K}_t \equiv \frac{K_t}{\gamma^t}.$$

The indirect period- t utility of the representative outsider can then be written as:

$$u_o(\tilde{k}_{ot}, \tilde{k}_{ot+1}) = \tilde{\beta}^t \frac{\Phi_o[w_{ot} + (1 + r_t - \delta)\tilde{k}_{ot} - \gamma\tilde{k}_{ot+1}]^{1-\rho}}{p_{xt}^{\alpha(1-\rho)}},$$

where $\Phi_o \equiv \alpha^{\alpha(1-\rho)}(1 - \alpha)^{\alpha(1-\rho)}$. Using this, the Bellman equation for the representative outsider can be rewritten as

$$\tilde{v}_o(\tilde{S}, \tilde{k}_o) = \max_{0 \leq \tilde{k}'_o \leq \gamma^{-1}[w_o + (1+r-\delta)\tilde{k}_o]} \left\{ u_o(\tilde{k}_o, \tilde{k}'_o) + \tilde{\beta} \tilde{v}_o(\tilde{S}', \tilde{k}'_o) \right\} \text{ s.t. } \tilde{S}' = G(\tilde{S}).$$

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 state variable as $X \equiv [0, \max\{\tilde{k}_o, \bar{k}\}]$ and the correspondence describing

the feasibility constraints as $\Gamma : X \rightarrow X$ by $\Gamma(\tilde{k}_o) \equiv [0, \gamma^{-1}\{w_o + (1 + r - \delta)\tilde{k}_o\}]$. 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 by noting that the problem of the representative insider coalition is trivial for $\omega = 0$. If they do not adopt the most efficient technology, then the insider marginal product in the intermediate good sector is strictly smaller than that of the outsiders. If they do adopt the most efficient technology, then the insider marginal product in the intermediate good sector is the same as that of the outsiders. Thus, the coalition cannot improve upon adopting the most efficient technology. However, it is indifferent between all technology choices. The reason is that if it does not adopt the most efficient technology, then the insiders will work in services where they earn the same wage as the outsiders do in services and manufacturing.

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 (11c) and (11f) gives that along the BGP, the capital–labor ratio is given by:

$$\frac{\tilde{K}_{xt}}{L_{xt}} = \frac{\tilde{K}_{zt}}{L_{zt}} = \left[\frac{\beta\theta}{\gamma^\rho - \beta(1 - \delta)} \right]^{\frac{1}{1-\theta}}. \quad (13)$$

Using that $\tilde{K}_{xt} = \tilde{K}_t - \tilde{K}_{zt}$ and that $\tilde{L}_{xt} = 2 - \tilde{L}_{zt}$, we also have

$$\frac{\tilde{K}_t}{2} = \left[\frac{\beta\theta}{\gamma^\rho - \beta(1 - \delta)} \right]^{\frac{1}{1-\theta}}. \quad (14)$$

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

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

The demand for consumption manufacturing goods is

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

Substituting equations (13) and (14) into this equation and rearranging, we find:

$$\frac{L_{zt}}{2} = (1 - \alpha)(1 - \theta) + [(1 - \alpha)\theta + \delta + \gamma - 1] \frac{\beta\theta}{\gamma^\rho - \beta(1 - \delta)} \quad (15)$$

Assumption 2 ensures that this condition is satisfied for a unique $L_{zt} \in (0, 1)$.

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 γ . Given that from the previous proposition τ_t also grows at rate γ , it follows that the quantities of all goods grow at rate γ 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:²

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

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

²Tildes again denote variables deflated by γ^t .

implying

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

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

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

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 (13), we can see that both capital stocks 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 productions of the two goods are smaller too.

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 good sectors and

that from (19)

$$\tilde{K}_t = (1 + (1 - \omega)\gamma^{t-\tau_t})\tilde{K}_{zt},$$

we obtain the consumption demand for manufacturing goods in period t :

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

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

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

Condition (10a) from Assumption 3 in the text ensures that the left-hand side is smaller than the right-hand side when $\tau_t = t$; Condition (10b) from Assumption 3 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 (12a) into (12b) and (12e) and (12f), 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 (12c) with the production function from (5):

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

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 (12e), 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:

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

Finally, the insider wage results after substituting (23) and (24) into (21b):

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

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

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

The first inequality means that the production in the intermediate good sector is more efficient than before, the second inequality means that the service good is cheaper than before. That is inconsistent with market clearing. Third, if the insiders were indifferent now, then there would be two subcases. If the outsiders worked only in the intermediate good sector, then the insider could increase their wage by lowering $\tilde{\tau}_t$. If the outsiders worked only in services, then

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

Thus, the relative price of services is larger than before. This again is inconsistent with market clearing ...