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Berthold Herrendorf – Arilton Teixeira
Research Department
24.2.2004

Monopoly rights can reduce income big time

Suomen Pankin keskustelualoitteita
Finlands Banks diskussionsunderlag

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Abstract

We ask which part of the observed cross-country differences in the level of per capita income can be accounted for by monopoly rights in the labour market. We answer this question in a calibrated growth model with two final goods sectors. The novel feature being that monopoly rights in the capital-producing sector shield insiders from competition by outsiders and permit coalitions of insiders to choose inefficient technologies or working practices. We find that monopoly rights can lead to quantitatively much larger reductions in the level of per capita income than previously demonstrated. This comes about because they do not only reduce TFP in capital-producing sector but also increase the relative price of capital. This reduces the capital-labour ratio in the whole economy. The implied predictions about the price of capital goods relative to consumption goods and the investment share in output are quantitatively consistent with the cross-country facts.

Key words: cross-country income differences, cross-country productivity differences, monopoly rights, relative price of capital, capital accumulation.

JEL classification numbers: EO0, EO4

Monopolivoima voi vähentää tuloja rajusti

Suomen Pankin keskustelualoitteita 7/2004

Berthold Herrendorf – Arilton Teixeira
Tutkimusosasto

Tiivistelmä

Tässä työssä tarkastellaan kysymystä, missä määrin henkeä kohti lasketun tulotason erojen eri maiden välillä voidaan selittää johtuvan työmarkkinoiden monopolisoitumisesta. Kysymykseen vastataan kalibroidulla kasvumallilla, jossa talous on jaettu kahteen lopputuotteita tuottavaan sektoriin. Uusi piirre mallissa on, että monopolivoima pääomatavaroita tuottavalla sektorilla suojaa sisäpiiriä ulkopuoliselta kilpailulta ja antaa sille mahdollisuuden käyttää tehotonta tekniikkaa tai tehottomia työtapoja. Tulokset osoittavat, että monopolivoima työmarkkinoilla voi johtaa paljon suurempaan tulotason laskuun kuin aiemmin on pystytty osoittamaan. Tulos johtuu siitä, että monopolivoima ei ainoastaan heikennä tuottavuutta pääomatavaroita tuottavalla sektorilla vaan myös nostaa pääoman suhteellista hintaa. Pääoman kallistuminen supistaa pääoma-työsuhdetta koko taloudessa. Kansainvälisessä aineistossa pääoma- ja kulutustavaroiden hintasuhde ja talouden investointiaste käyttäytyvät mallin ennustamalla tavalla.

Avainsanat: kansainväliset tuloerot, kansainväliset tuottavuuserot, monopolivoima, pääoman suhteellinen hinta, pääomanmuodostus

JEL-luokittelu: EO0, EO4

Contents

1 Introduction

There are large cross-country differences in the levels of per-capita income. For example, the Penn World Table of 1996 (PWT96 henceforth) report that the average per-capita income of the richest ten percentile of countries is about thirty times that of the poorest ten percentile.[1] We ask which part of the observed cross-country differences in income levels can be accounted for by monopoly rights in the labor market. We define monopoly rights as follows: certain types of workers, which we call insiders, have a monopoly in supplying labor in certain sectors; coalitions of these insiders also have the right to block efficient technologies and best-practice working arrangements, which are available once they are developed elsewhere.

Real-world examples of coalitions of insiders are brotherhoods, guilds, professional associations, and trade unions and their blocking activities are documented by many case studies, including Clark (1987), Mokyr (1990), Wolcott (1994), McKinsey-Global-Institute (1999), Holmes and Schmitz (2001a, b), and Schmitz (2001b). The paper by Wolcott (1994) provides an instructive example of blocking by coalitions of insiders. She compares the Japanese and the Indian Textile Industries between 1920 and 1938. In 1920, both industries had comparably low levels of output per worker. However, over the next 18 years, output per worker in Japan increased threefold whereas it remained stagnant in India. Moreover, Total Factor Productivity (TFP henceforth) in Japan increased by 61 percent in spinning and by 77 percent in weaving whereas these measures in India increased by only 1 and 21 percent. Finally, in the Japanese textile industry the real wage increased by 3 percent more than in agriculture, whereas in the Indian textile industry it increased by 13 percent more than in agriculture. Wolcott documents that the main difference between Japan and India lay in the working arrangements. Most importantly, in Japan rationalization drastically increased the number of machines each worker handled whereas in India this did not happen. Wolcott argues that differences in the characteristics of the workforce are responsible for the different experiences. In particular, the workers in Japan were predominately young women, who worked in the textile industry only for some years. There were no labor unions in Japan. The workers in India were predominately adult males, who worked in the textile industry for most of their lives. There were strong labor unions in India. As a result the Bombay region alone witnessed about 1000 strikes in the inter-war period, most of which were aimed at preventing measure of rationalization that would have improved labor productivity and reduced employment.

The recent theoretical literature that models the implications of monopoly rights in the labor market includes Holmes and Schmitz (1995), Parente and Prescott (1999, 2000), Bridgeman et al (2001), and Herrendorf and Teixeira (2002). Parente and Prescott (1999) is most closely related to the project underlying the present paper. They find that the per-capita income level with competition is 2.7 times higher than with monopoly rights. In deriving

[1] Parente and Prescott (1993) and McGratten and Schmitz (1999) offer a detailed analysis of cross-country data.

this result, Parente and Prescott abstract from capital. In contrast, we do not abstract from capital but embed monopoly rights into a standard neoclassical growth model with two final goods sectors. Analyzing the implications of monopoly rights when there is capital is important for two reasons. First, it will turn out that capital greatly amplifies the distortionary effects of monopoly rights. This confirms a conjecture of Parente and Prescott (1999) and shows that capital is essential for understanding the quantitative implications of monopoly rights. Second, our model will be consistent both with several key development facts and with Kaldor's growth facts. Therefore, our theory of development is also a theory of growth, which is desirable because the two fields are closely related.

We consider an economy with two final goods sectors, which we call the service sector and the manufacturing sector. The service sector produces a consumption good and the manufacturing sector produces a consumption good and a capital good. The inputs in the production of the service good are capital and labor; the inputs in the production of the manufactured goods are many intermediate goods, each of which is produced with capital and labor. The economy is populated by many individuals, who can work in either sector and who can save by investing in physical capital. There are two types of individuals: insiders and outsiders. The only difference between insiders and outsiders comes from the institutional arrangement: the insiders can have a monopoly of supplying labor in their intermediate good sector. If they do, then the entry of outsider labor into their intermediate good sector is restricted. If they do not, then the entry of outsider labor into their intermediate good sector is not restricted. Moreover, the insiders of each intermediate good sector form a coalition that has the right to choose the insider productivity in that sector; the outsiders do not belong to any coalition.

Our main finding is that differences in the strength of monopoly rights account for a quantitatively substantial part of the cross-country differences in income levels. Our baseline calibration uses the PWT96, a capital share of 0.4, and assumes that the higher prices of capital relative to consumption in poor countries come from stronger monopoly rights. For this baseline calibration, we find an income level difference of a factor of 10.8 between the BGP equilibria with competition and with monopoly rights. A difference of a factor 10.8 is four times the difference of a factor 2.7 found by Parente and Prescott (1999) for a model economy without capital. Monopoly rights have a larger effect in our model economy with capital because their standard direct effect is accompanied by an indirect effect. The direct effect is that monopoly rights allow the insider coalitions to reduce the insider productivity. This leads to the inefficient production of the intermediate inputs for the manufactured goods. The indirect effect is that the reduced insider productivity increases the price of intermediate goods and thus of manufactured goods relative to services. Since capital is a manufactured good, this reduces the capital-labor ratio in the service sector. Our quantitative results show that this indirect effect greatly amplifies the direct effect of monopoly rights.

Our model economy does quantitatively well also with respect to three other features of the development data. (i) It predicts that the price of capital relative to consumption is higher in poor than in rich countries. This consistent

with the evidence reported by Jones (1994), Chari et al (1996), Eaton and Kortum (2001), and Restuccia and Urrutia (2001). In our model the price of capital relative to consumption is higher in poor economies because the price of services (which are an important part of consumption) relative to domestic capital is lower. In contrast, the price of domestic capital relative to foreign capital is independent of the income level. Both these features are consistent with the evidence reported by Hsieh and Klenow (2002). (ii) Our model predicts that measured in domestic prices, rich countries invest the same output shares as poor countries; measured in international prices, rich countries invest considerably larger output shares than poor countries. Furthermore, the predicted shares are quantitatively close to those in the data. (iii) Our model predicts that rich countries use their resources more efficiently than poor countries, so cross-country differences in TFP account for a substantial part of the differences in income levels. The predicted TFP differences are quantitatively within the range reported by Caselli et al (1996), Klenow and Rodriguez-Clare (1997), Prescott (1998), Hall and Jones (1999), and Caselli and Coleman (2003).

2 Model economy

2.1 Environment

Time t is discrete and runs forever. There is no uncertainty. There are two final consumption goods s and m, a capital good x, and a continuum of intermediate goods z_i, $i \in [1,2]$. The consumption good s is produced in the service sector while the consumption good m and the capital good x are produced in the manufacturing sector. The service good and the intermediate goods are not tradable; the two manufactured goods are tradable and the economy is small in that it does not affect the world market price of the tradable goods. The motivation for assuming that the manufactured goods are tradable and the service goods are not comes from the evidence reported by Hsieh and Klenow (2002): the price of services relative to domestic capital is lower is poor countries than in rich countries whereas the price of domestic capital relative to foreign capital is unrelated to the per-capita income level. Otherwise trade will play no role in our model.

There are unit rectangles of outsiders and insiders. The outsiders are identical whereas the insiders are not: in each intermediate good sector z_i there is a unit interval of insiders of type i, $i \in [1,2]$. Each individual is endowed with one unit of time in each period and with a positive initial capital stock. The individual problems are:

$$\max_{\{s_{\iota t},\, m_{\iota t},\, k_{\iota t+1}\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t \frac{\left(s_{\iota t}^{\alpha} m_{\iota t}^{1-\alpha}\right)^{1-\rho} - 1}{1-\rho} \tag{2.1}$$

$$\text{s.t.} \quad p_{st} s_{\iota t} + p_{mt} m_{\iota t} + p_{xt}[k_{\iota t+1} + (\delta - 1) k_{\iota t}] = r_t k_{\iota t} + w_{\iota t} + \pi_{\iota t},$$

$$s_{\iota t}, m_{\iota t}, k_{\iota t+1} \geq 0, \quad k_{\iota 0} > 0 \text{ given.}$$

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; $\alpha \in (0,1)$ is the expenditure share of services; $\rho \in [0,\infty)$ is the inverse of the intertemporal elasticity of substitution; $k_{\iota t+1}$ and $k_{\iota t}$ are the capital stocks held by the representative individual of type ι and $\delta \in [0,1]$ is the depreciation rate of installed capital, so $k_{\iota t+1}+(\delta-1)k_{\iota t}$ is the period-t investment of the representative individual of type ι; p_{st}, p_{mt}, and p_{xt} are the prices of services, manufactured consumption goods, and capital goods relative to the foreign capital good, which is the numeraire; r_t and $w_{\iota t}$ are the rental rate of installed capital and the wage rate; $\pi_{\iota t}$ are profits.

We continue with production. The representative firm in the service sector maximizes its profits in each period:

$$\max_{s_t,\, k_{st},\, l_{sot},\, l_{sit}} p_{st}s_t - r_t k_{st} - w_{ot}l_{sot} - \int_1^2 w_{it}l_{sit}di \tag{2.2}$$
$$\text{s.t. } s_t = Ak_{st}^{\theta}(\gamma^t l_{st})^{1-\theta}, \quad l_{st} = l_{sot} + \int_1^2 l_{sit}di, \quad s_t, k_{st}, l_{sit} \geq 0, \quad l_{sot} > 0.$$

$A > 0$ is a constant that determines the units of services;[2] k_{st} is capital allocated to the service sector, l_{st} is total labor allocated to the service sector, and l_{sot} and l_{sit} are the labor that outsiders and insiders of type i allocate to the service sector; $\theta \in (0,1)$ is the capital share; $\gamma - 1 \in [0,\infty)$ is the exogenous growth rate of labor-augmenting technical progress. This formulation contains the restriction $l_{sot} > 0$ on the outsiders' labor supply, which ensures that some outsiders work in the service sector. This will rule out odd equilibria in which only the insiders work in the service sector.

The representative firm in the manufacturing sector maximizes its profits in each period:

$$\max_{m_t,\, x_t,\, z_{it}} p_{mt}m_t + p_{xt}x_t - \int_1^2 p_{z_it}z_{it}di \tag{2.3}$$
$$\text{s.t. } \mu m_t + x_t = \left(\int_1^2 z_{it}^{\frac{\sigma-1}{\sigma}}di\right)^{\frac{\sigma}{\sigma-1}}, \quad m_t, x_t, z_{it} \geq 0.$$

p_{z_it} is the price of the intermediate good z_{it} relative to the foreign capital good, $\mu > 0$ is a constant that determines the units of m_t,[3] and $\sigma \in (0,\infty)$ is the elasticity of substitution between different intermediate goods. We will need that the manufacturing sector's demand for each intermediate good is inelastic: $\sigma < 1$. This is as in Parente and Prescott (1999) and can be guaranteed by considering sufficiently broad categories of goods (BMW cars versus Mercedes cars or cars versus bicycles).

[2] The common practice is to normalize units such that $A = 1$. Our reason for deviating from that practice will become clear in section 4 below.

[3] The common practice is to normalize units such that $\mu = 1$. Our reason for deviating from that practice will become clear in section 4 below.

The representative firm in the i–th intermediate good sector maximizes its profits in each period:

$$\begin{aligned} &\max_{z_{it},\, k_{z_it},\, l_{z_iot},\, l_{z_iit}} p_{z_it} z_{it} - r_t k_{z_it} - w_{ot} l_{z_iot} - w_{it} l_{z_iit} \\ \text{s.t.}\;\; & z_{it} = k_{z_it}^{\theta} (\gamma^t l_{z_it})^{1-\theta}, \quad l_{z_it} = (1-\omega) l_{z_iot} + b_{it} l_{z_iit}, \\ & z_{it}, k_{z_it}, l_{z_iot} \geq 0, \quad l_{z_iit} > 0. \end{aligned} \tag{2.4}$$

l_{z_it}, l_{z_iot}, and l_{z_iit} are total labor, outsider labor, and insider labor allocated to the i–th intermediate good sector, $\omega \in [0,1)$ is a constant, and $b_{it} \in [0,1]$ is a variable that affects the insider productivity. This formulation contains two implicit restrictions on the insiders' labor supply. First, we have assumed that some insiders of the i–th intermediate good sector work there: $l_{z_iit} > 0$. This will rule out odd equilibria in which the insiders do not work in their sector. Second, we have assumed that the insiders of the i–th intermediate good sector can only work in that sector or in the service sector, but not in the other intermediate good sectors. Since we will restrict our attention to symmetric equilibrium with respect to the different types of insiders and the different sectors, this is without loss of generality.

We assume that the institutional arrangement gives a monopoly right to the insiders of each intermediate good sector. To introduce the monopoly, we set $b_{it} = 1$ for a moment. If $\omega = 0$ in addition, then insider and outsider labor are perfect substitutes and the insiders of the i–th intermediate good sector have no monopoly power. We will refer to this case as competition. In contrast, if $b_{it} = 1$ and $\omega > 0$, then insider and outsider labor are imperfect substitutes and the insiders have monopoly power. We will refer to this case as monopoly. The strength of the monopoly power increases in the value of ω, which summarizes the restrictions on outsider labor in sector z_i. To introduce the right, we return to the general case $b_{it} \in [0,1]$. We assume that the insiders of the i–th intermediate good sector form a coalition that has the right to choose the insider productivity b_{it}. It makes that choice at the same time when the other decisions of period $t-1$ are taken and its objective is to maximize the present value of the representative insider's utility. Note that the assumption that $b_{it} \in [0,1]$ implies that the coalition can choose arbitrarily inefficient technologies and work practices. Moreover, note that there are no costs of maintaining the highest productivity and there are no vintage-specific skills.

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

$$S_t = S_{ot} + \int_1^2 S_{it}\, di, \tag{2.5a}$$

$$M_t + M_t^* = M_{ot} + \int_1^2 M_{it}\, di, \tag{2.5b}$$

$$X_t + X_t^* = K_{ot+1} + (\delta - 1)K_{ot} + \int_1^2 K_{it+1} + (\delta - 1)K_{it}\, di, \tag{2.5c}$$

$$K_{ot} + \int_1^2 K_{it}\, di = K_{st} + \int_1^2 K_{z_i t}\, di, \tag{2.5d}$$

$$1 = L_{sot} + \int_1^2 L_{z_i ot}\, di, \tag{2.5e}$$

$$1 = L_{sit} + L_{z_i it}, \quad i \in [1, 2]. \tag{2.5f}$$

The first two market clearing conditions require that the markets for the two consumption goods clear, the third condition requires that the market for new capital goods clear, the fourth condition requires that the rental market for installed capital clear, and the last two conditions require that the different labor markets clear. M_t^* and X_t^* denote the imports of M_t and X_t.

We have abstracted from borrowing and lending between insiders and outsiders and between domestic and foreign individuals. This is without loss of generality because we will only compare different BGP equilibria. Without borrowing and lending between domestic and foreign individuals, international trade is balanced in each period, ie $p_{mt}M_t^* + p_{xt}X_t^* = 0$. Consequently, international trade will just pin down the relative prices of tradable goods at $p_{mt} = \mu$ and $p_{xt} = 1$. Without loss of generality, we can therefore restrict imports and exports: $M_t^* = X_t^* = 0$.

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 level. We restrict attention to equilibria with the following properties: (i) they are symmetric with respect to insiders, the outsiders, the coalitions, and the intermediate goods sectors; (ii) they are recursive in that in each period all decision makers condition their actions on the state variables only. Recall that all agents make their choices simultaneously.

We first specify the state variables. Since we consider symmetric equilibrium only, we can drop the index indicating the intermediate good sector. As before, we denote the individual states by lower-case letters and the economy-wide averages of individual states by upper-case letters. So, the outsiders' and insiders' individual holdings of capital are k_o and k_i and their economy-wide average holdings are K_o and K_i. Moreover, B is the economy-wide average in-

sider productivity parameter and b is the insider productivity parameter in an intermediate good sector. For compactness, we abbreviate the economy-wide state:

$$F \equiv (B, K_i, K_o).$$

The law of motion of the economy-wide state is denoted by:

$$F' = (B, K_i, K_o)' = G(F) = (G_B, G_{Ki}, G_{Ko})(B, K_i, K_o).$$

We will also need the sector-wide average of the insiders' capital holdings, which we denote by $\bar{k}_i$. The law of motion of the sector-wide state is:

$$(b, \bar{k}_i)' = \bar{g}(b, \bar{k}_i) = (\bar{g}_b, \bar{g}_{ki})(b, \bar{k}_i).$$

After this investment in notation, we can write the dynamic problems in recursive form.[4] Calling the representative outsider's value function v_o, the recursive version of his problem is:

$$\begin{aligned} v_o(F, k_o) &= \max_{s_o, m_o, k_o' \geq 0} \{u(s_o, m_o) + \beta v_o(F', k_o')\} \qquad (2.6) \\ s.t.\ \ & p_s(F)s_o + p_m(F)m_o + p_x(F)[k_o{}' + (\delta - 1)k_o] \\ & = r(F)k_o + w_o(F) + \pi_o(F), \\ & F' = G(F). \end{aligned}$$

In words, the representative outsider chooses his current consumption and his future capital stock, taking as given the economy-wide state F, the corresponding law of motion G, and his own capital stock k_o. The solution to this problem implies the policy function $(s_o, m_o, k_o') = (g_{so}, g_{mo}, g_{ko})(F, k_o)$.

The recursive problem of the representative insider is:

$$\begin{aligned} v_i(F, b, \bar{k}_i, k_i) &= \max_{s_i, m_i, k_i' \geq 0} \{u(s_i, m_i) + \beta v_i(F', b', \bar{k}_i', k_i')\} \qquad (2.7) \\ s.t.\ \ & p_s(F)s_i + p_m(F)m_i + p_x(F)[k_i' + (\delta - 1)k_i] \\ & = r(F)k_i + w_i(F, b) + \pi_i(F), \\ & (F, b, \bar{k}_i)' = (G(F), \bar{g}(F, b, \bar{k}_i)). \end{aligned}$$

In words, the representative insider chooses his current consumption and his future capital stock, taking as given the economy-wide state F, the corresponding law of motion G, the insider productivity parameter b and the average insider capital of his sector $\bar{k}_i$, the corresponding law of motion $\bar{g}$, and his own capital stock k_i. The solution to this problem implies the policy function $(s_i, m_i, k_i)' = (g_{si}, g_{mi}, g_{ki})(F, b, \bar{k}_i, k_i)$.

The recursive problem of the representative coalition is:

$$\begin{aligned} v_c(F, b, \bar{k}_i) &= \max_{b' \in [0,1]} \{u(g_{si}(F, b, \bar{k}_i, \bar{k}_i), g_{mi}(F, b, \bar{k}_i, \bar{k}_i)) \qquad (2.8) \\ & + \beta v_c(F', b', \bar{k}_i')\} \\ s.t.\ \ & (F, \bar{k}_i)' = (G(F), \bar{g}_{ki}(F, b, \bar{k}_i)). \end{aligned}$$

[4]The problems of the three representative firms are static, so we do not need to rewrite them.

In words, the representative insider coalition chooses the future insider productivity in its sector so as to maximize the indirect insider utility (plus the continuation value), taking as given the economy-wide state F, the corresponding law of motion G, the sector-wide state $(b, \bar{k}_i)$, and the law of motion of the sector-wide average insider capital, $\bar{g}_{ki}$. A solution to this problem implies the policy function $b' = g_b(F, b, \bar{k}_i)$.

Recall that the only implication that trade has for the equilibrium is to determine the relative prices of the tradable goods: $p_{mt} = \mu$ and $p_{xt} = 1$. Therefore, these relative prices are exogenous to the domestic economy.

Definition 2.1 (Equilibrium) *Given $p_{mt} = \mu$, $p_{xt=1}$, and $M_t^* = X_t^* = 0$, an equilibrium is*

- *price functions $(p_s, w_o, r)(F)$, $(p_z, w_i)(F, b)$;*
- *allocation functions for the three types of firms, $(s, k_s, l_{so}, l_{si})(F)$, $(m, x, z)(F)$, (z, k_z, l_{zo}, l_{zi}) (F, b),*
- *laws of motion $F' = G(F)$ and $(b, \bar{k}_i)' = \bar{g}(F, b, \bar{k}_i)$;*
- *value functions $v_o(F, k_o)$, $v_i(F, b, \bar{k}_i, k_i)$, $v_c(F, b, \bar{k}_i)$;*
- *policy functions*

$$\begin{aligned}(s_o, m_o, k_o') &= (g_{so}, g_{mo}, g_{ko})(F, k_o),\\ (s_i, m_i, k_i') &= (g_{si}, g_{mi}, g_{ki})(F, b, \bar{k}_i, k_i),\\ b' &= g_b(F, b, \bar{k}_i);\end{aligned}$$

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 (2.6), (2.7), and (2.8);*
- *the policy functions solve the problems of the representative individuals, (2.6) and (2.7), and of the representative coalition, (2.8);*
- *the policy functions and the laws of motion are consistent:*

$$\begin{aligned}G_{Ko}(F) &= g_{ko}(F, K_o),\\ G_{Ki}(F) &= \bar{g}_{ki}(F, B, K_i) = g_{ki}(F, B, K_i, K_i),\\ G_B(F) &= \bar{g}_b(F, B, K_i) = g_b(F, B, K_i);\end{aligned}$$

- *markets clear, (2.5).*

3 Analytical results

We now study the BGP equilibria of the model economy with competition and with monopoly. Recall that these two cases correspond to $\omega = 0$ and $\omega > 0$ and that an increase in ω corresponds to an increase in the strength of the monopoly. For convenience the coalition maintains the right to choose its members productivity also if $\omega = 0$, which has no effect on the BGP equilibrium. To ensure that the individual utility functions are finite, we need the standard restriction that the growth rate of labor-augmenting technological progress is not too large relative to the discount factor: $\tilde{\beta} \equiv \beta\gamma^{1-\rho} \in (0,1)$. To ensure that a BGP equilibrium exists with monopoly, we need two additional restrictions:

Assumption 3.1

$$\alpha\beta\theta\left(\gamma+\delta-1\right)\left(2-\omega\right) < \left[\alpha-\left(1-\alpha\right)\left(1-\omega\right)\right]\left[\gamma^{\rho}+\beta\left(\delta-1\right)\right], \quad (3.1a)$$

$$2\alpha\beta\theta\left(\gamma+\delta-1\right) > \left(2\alpha-1\right)\left[\gamma^{\rho}+\beta\left(\delta-1\right)\right]. \quad (3.1b)$$

These two restrictions are satisfied for standard calibrations like that of section 4 below.

Proposition 3.1 (BGP equilibrium with competition, $\omega = 0$) *There exists a unique BGP equilibrium. Along the BGP equilibrium*
(a) the capital stocks and all sectors' outputs grow at rate $\gamma - 1$;
(b) productivity in the intermediate good sectors is constant and as high as possible: $b_t = 1$;
(c) the relative price of services is constant: $p_{st} = A^{-1}$;
(d) the outsiders and the insiders are indifferent between the service sector and the intermediate good sectors.[5]

Proof. See the Appendix. ■

Proposition 3.2 (BGP equilibrium with monopoly, $\omega > 0$) *Let Assumption 3.1 hold. There exists a unique BGP equilibrium. Along the BGP equilibrium*
(a) the capital stocks and all sectors' outputs grow at rate $\gamma - 1$;
(b) productivity in the intermediate good sectors is constant and lower than is possible: $b_t = b \in (1-\omega, 1)$;
(c) the relative price of services is constant: $p_{st} = (1-\omega)^{1-\theta}A^{-1}$;
(d) the outsiders work only in the service sector but are indifferent between the service sector and the intermediate good sectors, the insiders work in their intermediate good sector and strictly prefer that.

Proof. See the Appendix. ■

[5] Strictly speaking the BGP equilibrium is not unique because outsider and insider labor are perfect substitutes so their allocation is indeterminate. However, this indeterminacy is irrelevant because it does not have any consequences for the other equilibrium quantities.

Why does the representative coalition find it optimal to choose a lower productivity than is possible when it has monopoly power? To answer this question, consider for a moment what a monopolist producer in an intermediate sector would do. He would choose a higher relative price than the competitive one so as to restrict production. In our environment with inelastic demand, the optimal choice would be the highest price at which entry does not occur. Thus, a monopolist producer would make other firms just indifferent between entering and staying out. Now let us turn back to the insider coalition in an intermediate sector. It cannot directly choose a higher relative price because the price is determined by competition among the firms. However, it can indirectly choose a higher relative price by choosing an inefficient insider productivity. Given that the demand for intermediate goods is inelastic, choosing an inefficient productivity increases the real insider income because it increases the relative price by more than it decreases the insiders' marginal product. The insiders' monopoly power is limited by the entry of outsiders into the intermediate goods sector. If entry occurs the relative price is determined because the outsiders must earn the same wage in the service sector as in the intermediate good sector. Choosing an even lower insider productivity then only decreases the marginal insider product, and so the real insider income. Thus, the insider coalition's optimal productivity choice results in a relative price that just makes the outsiders indifferent between the service sector and the intermediate good sector. One key ingredient in this argument is that the demand for the intermediate good is inelastic. We could generalized this. First we could assume that the insiders bear a marginal cost of producing an additional unit of the intermediate good. This would arise, for example, if the insiders had a labor-leisure choice. Second, we could assume that capital can substitute for unproductive insider labor when firms take costly investments. We leave pursuing these generalizations to future work.

The implications of our model are consistent with the standard growth facts and with the development facts described in the introduction. To generate the growth implications, we need to keep the strength of the monopoly power constant. It then easy to show that for any $\omega \in [0, 1)$ the unique BGP equilibrium is consistent with Kaldor's growth facts: per-capita income and per-capita capital grow at a constant rate; the capital-output ratio, the real interest rate, and the capital and labor shares in output are constant. To generate the development implications of our model, we need to vary the strength of monopoly power. We also need to define aggregate TFP, which is the residual that would result if aggregate output was produced from aggregate capital and labor according to an aggregate Cobb-Douglas production function with capital share θ:

$$TFP \equiv \frac{p_{st} K_{st}^{\theta} L_{st}^{1-\theta} + K_{zt}^{\theta} L_{zt}^{1-\theta}}{(K_{st} + K_{zt})^{\theta} (2\gamma^t)^{1-\theta}}, \tag{3.2}$$

Knowing the model, we know, of course, that this is incorrect. Computing aggregate TFP in this way is nonetheless useful, as it allows us to compare our results with those obtained by the empirical literature, which does exactly the same.

Proposition 3.3 (Development facts) *Let Assumption 3.1 hold.*
(a) Along any BGP equilibrium with $\omega \in [0,1)$ the growth rates of all real variables, the price of domestic capital relative to foreign capital, and the investment share measured in domestic prices are the same.
(b) Along any BGP equilibrium with monopoly, ie $\omega = 0$, the following variables are smaller than along the BGP equilibrium with competition, ie $\omega \in (0,1)$: the level of per-capita income; the price of services relative to capital goods; the investment share measured in international prices; TFP in the intermediate good sectors and aggregate TFP.
(c) Along different BGP equilibria, the following variables are smaller when ω is larger: the level of per-capita income; the price of services relative to capital; the investment share measured in international prices; TFP in the intermediate good sectors and aggregate TFP.

Proof. See the Appendix. ■

Out together, the different parts of this proposition imply that: (i) the relative price of services is positively correlated with per-capita income; (ii) measured in domestic prices the investment share in output is uncorrelated with income whereas measured in international prices it is positively correlated with income; (iii) TFP in the intermediate good sectors and aggregate TFP are positively correlated with income. These are qualitative versions of the development facts described in the introduction.

One may wonder why monopoly reduces the relative price of services, instead of increasing the relative prices of intermediate goods and manufactured goods. The reason is that in symmetric equilibrium both the prices of intermediate goods relative to the domestic capital and the price of the domestic capital relative to foreign capital must equal one. The latter holds because domestic capital is tradable in our model. An increase in the relative price of the intermediate goods relative to the domestic service good can then only come from a decrease in the price of the domestic service good relative to the intermediate and manufacturing goods. This is possible because domestic services are not tradable.

We end this section by noting that monopoly rights reduce the capital-labor ratios of *all* sectors, not just of the intermediate good sectors. This can be seen from the Euler equations, which along a BGP equilibrium become:

$$\theta \left(\frac{\gamma^t L_{zt}}{K_{zt}} \right)^{1-\theta} = p_{st} \theta \left(\frac{\gamma^t L_{st}}{K_{st}} \right)^{1-\theta} = \frac{\gamma^\rho}{\beta} - 1 + \delta. \tag{3.3}$$

Note that for $\omega \in (0,1)$, the insiders work only in the intermediate good sectors, implying that $L_{st} = 1$ and $L_{zt} = b_t$. The direct effect of monopoly rights is to decrease b_t, which 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 each symmetric BGP equilibrium. The indirect effect of monopoly rights is to decrease p_{st}, which makes allocating capital to the service sector more expensive and decreases the capital-labor ratio in services. Therefore, capital provides an amplification mechanism by which the monopoly distortion in the intermediate good sectors affects the competitive

service sector. This amplification mechanism turns out to be important for the quantitative analysis to which we turn now.[6]

4 Quantitative results

In this section, we explore the quantitative implications of monopoly rights. We first parameterize the model economy with competition by assuming that it corresponds to the ten percent richest countries in the world. We then parameterize the strength of the monopoly power, ω, by assuming that the difference in the price of services relative to capital between the richest and the poorest ten percentile comes from monopoly rights. We finally ask by how much the per-capita income level of the competitive economy changes if we replace competition by monopoly.

A model period is one year. Table 1 summarizes the parameter values for the benchmark calibration.[7] Instead of calibrating to the richest ten percent of countries, we go with the standard post-war values for the US if they are available. Our justification is that the US is by far the biggest and most studied economy in the top ten percentile and that it has the best data sources. As in Cooley and Prescott (1995), we therefore choose $\gamma = 1.0156$, $\rho = 1$, $\beta = 0.947$, and $\theta = 0.4$. We will explore our model economy also for other values of θ because there is some debate about the value of θ; see, for example, Gollin (2002). Note that we have restricted all sectors to have equal capital shares. Hsieh and Klenow (2002) find that this is a reasonable approximation for the US. In contrast, Echevarria (1997) finds that across the OECD, the average capital share in services is higher than in manufacturing (fifty versus forty percent). In light of this evidence, our choice of a capital share in services of forty percent is a conservative one, as the predicted differences in the per-capita income levels increase in the capital share.

To calibrate the remaining parameter values, we use data from the Penn World Tables. Following Hsieh and Klenow (2002), we use benchmark years because they are the only years for which price data are actually collected. Unfortunately the number and identity of the countries vary widely across the different benchmark years. We therefore gave up on the attempt of calibrating the BGP equilibrium under competition from a from panel of cross-country data and turned instead to the cross-section of the PWT96 (recall that PWT96 abbreviates the 1996 Penn World Tables). The PWT96 is the most recent available benchmark study and it has the advantage of being very broad: it contains 115 countries. We start by identifying the countries in the top and bottom ten percentiles of per-capita incomes, measured in international prices. We find the standard fact that the average per-capita income of the top ten percentile is about 30 times larger than that of the bottom ten percentile.

[6] Schmitz (2001a) makes a similar point: if the government produces investment goods inefficiently, then this reduces the labor productivity of all sectors that use these investment goods. Schmitz finds that this effect can cause an income difference of about factor three.

[7] Note that we do not need to choose a value for σ, because it drops out in symmetric equilibrium.

We proceed by assuming that the top ten percentile in the PWT96 corresponds to our economy under competition and use averages to calibrate δ, α, A, and μ. The value of δ determines the investment share in output measured in domestic prices. In the top ten percentile of the PWT96, the weighed average share equals 0.23, where the weights are the countries per-capita incomes in international prices relative to the total per-capita income in the top ten percentile. Given our choices of $\omega = 0$ and $\theta = 0.4$, we need to choose $\delta = 0.06$ to replicate this share. The value of α equals the expenditure share of non-tradable consumption goods in total consumption measured in domestic prices. In the top ten percentile of the PWT96, the weighed average share equals 0.58, where the weights are the countries' quantities of consumed services in international prices relative to the total quantity of consumed serviced in the top ten percentile.[8] The value of A determines the price of non-tradable consumption goods relative to tradable capital goods. In the top ten percentile of the PWT96, the weighed average relative price equals 0.78, where the weights are the countries quantities in international prices relative to the total quantity in the top ten percentile.[9] Since $p_{st} = A^{-1}$ along the BGP with competition, we choose $A = 1.28$. The value of μ determines the price of manufactured consumption goods relative to capital goods. Since both are assumed tradable and since we maintain the assumption of a small open economy, the corresponding price in the data is the international price of manufactured consumption goods relative to capital goods. This international price equals 0.47 and so we choose $\mu = 0.47$.[10]

Given the values of θ and A, the value of ω determines the price of the non-tradable consumption goods relative to capital goods in the economy with monopoly: $p_{st} = (1-\omega)^{1-\theta}A^{-1}$. The ratio between of this price in the poorest and richest ten percentile equals 7.7. Using $(1-\omega)^{\theta-1} = 7.7$ and $\theta = 0.4$, we thus set $\omega = 0.967$ in our benchmark calibration. At first sight, this may appear to be very large. However, $k_{z_it}^{\theta}(\gamma^t \omega l_{z_iot})^{1-\theta}$ remain strictly smaller

[8] Note that our assumption of a constant expenditure share of services is not validated by the data: the poorest ten percentile has an expenditure share of services of less than half of the richest ten percentile. Since in our model economy the service sector is the competitive sector, this goes against us.

[9] To be precise the price in a country is the weighed average of the prices of the different categories of goods. The average price across a percentile of countries is the weighed average of the prices. In both cases, the weights are the quantities relative to the relevant total quantity measured in international prices. As capital goods we classified all capital goods including non-tradable construction. As tradable consumption goods we classified beverages, bread and cereal, cheese and eggs, clothing (including repair), fish, floor covering, fruit, fuel and power, furniture, household appliances and repairs, household goods and textiles, meat, milk, oil and fat, other food, personal transportation equipment, tobacco, and vegetables and potatoes. As non-tradable consumption goods we classified cafes and hotels, communication, education, gross rent and water charges, medical health care, operation of transportation equipment, purchase transportation service, recreation and culture, restaurants, and other goods and services.

[10] The international price is defined recursively. The international price of a category of goods equals the weighed average of the prices of that category in the different countries; the weights are the quantities relative to the total quantity and the prices in the countries are the domestic prices multiplied with the purchasing-power-parity of the domestic currency; the purchasing-power-parity equals the ratio between the values of the domestic goods basket evaluated in domestic prices and in international price.

than the labor share times the annual output of the intermediate good sector. Parente and Prescott (1999) argue that the costs of breaking labor market monopolies can easily be of this order magnitude. A different way to establish that the strength of monopoly rights are reasonable is to look at the implied premium of the insider wage over the outside wage. In our model, it equals 30 percent for the benchmark calibration. A wage premium of 30 percent is very reasonable for an economy with strong monopoly rights, given the size of the observed inter-industry wage differentials in the US for workers with the same characteristics. Holmes and Schmitz (2001a), for example, report that in New Orleans in the mid 1880s screwmen and longshoremen earned monopoly wage premia of between 18 and 31 percent of the total transportation costs of the goods they handled. Given a labor share of 60 percent, a wage premium of 30 percent translates into 18 percent of the total production costs (recall that the producers make zero profits in our model). Another piece of evidence comes from Krueger and Summers (1988), who report large and persistent wage premia in the 1980s. For example, in 1984 the workers in US automobile manufacturing received a wage premium of nearly 30 percent over the average wage of all workers with the same characteristics.

Table 1: Benchmark Calibration

γ	ρ	β	θ	δ	α	A	μ	ω
1.0156	1	0.947	0.4	0.06	0.58	1.28	0.47	0.967

Table 2 summarizes the quantitative results. The numbers in the boldfaced line correspond to our benchmark calibration. The first column indicates the capital shares other than $\theta = 0.4$ that we have explored. Note that when θ changes, we need to re-calibrate the values of δ and ω so as to maintain unchanged the investment share in domestic prices and the ratio of the relative prices of services. The second column reports the ratios of the per-capita incomes with competition and with monopoly. In all cases, we compute per-capita income as in the PWT96, so the quantities generated by the model are evaluated at international prices p^* from the PWT96:

$$Y(m, p^*) = p_s^* S(\omega) + p_m^* M(\omega) + p_x^* X(\omega).$$

This makes sense because we have chosen units such that all relative prices under competition are as in the top ten percentile of the PWT96, so the units in the model are equal to the units in the PWT96. We see that the ratio between the level of per-capita income with competition and monopoly is between a factor of 6 and 30. For our baseline calibration $\theta = 0.4$, the result is a factor of 10.8. This is four times the factor of 2.7 reported by Parente and Prescott (1999) for a model without capital accumulation. The last line of Table 2 reports that for a capital share of 0.54 our model economy generates roughly the observed income ratio of 30. While we think that capital shares of this size are on the very high end of plausible capital shares, the result is interesting in light previous work: Mankiw et al (1992) and Chari et al (1996) found that

without cross-country differences in TFP, a much larger capital share of 0.7 is needed to generate the observed income difference. We will return to this issue in the next section when we discuss a tax distortions as an alternative to the monopoly rights distortion.

Table 2: Quantitative results monopoly economy
(c for competition, m for monopoly, p^* for international prices)

θ	$\frac{Y(c,p^*)}{Y(m,p^*)}$	$\frac{I(c,p^*)}{Y(c,p^*)}$	$\frac{I(m,p^*)}{Y(m,p^*)}$	$\frac{TFP_z(c)}{TFP_z(m)}$	$\frac{TFP(c)}{TFP(m)}$
0.3	6.6	0.29	0.12	6.6	2.9
0.35	8.3	0.29	0.12	6.7	2.9
0.4	**10.8**	**0.29**	**0.12**	**6.7**	**2.9**
0.45	14.6	0.30	0.12	6.8	2.9
0.54	30.2	0.29	0.12	6.9	2.9

The third and fourth columns of Table 2 report the investment shares in output with competition and with monopoly, both measured in international prices. The predicted investment shares are reasonably close to those found in the PWT96, where the richest and poorest ten percentiles invest 27 and 10 percent of output measured in international prices. Note that the model also performs well with respect to the investment share measured in domestic prices. While, by construction, we match the 23 percent that the richest ten percentile invest, we predict the same percentage for the poorest ten percentile. This is consistent with the finding of Hsieh and Klenow (2002) that across countries the investment share measured in domestic prices is unrelated to the per-capita income level.

The fifth column reports the ratios between TFP in the intermediate goods sectors with competition and monopoly. The model predicts that TFP in the intermediate goods sectors with competition be between 6.6 and 6.9 times larger than TFP with monopoly. Sector TFP differences of that order magnitude are well within reason. For example, the estimates of Harrigan (1999) show that a difference in sector TFP of a factor 2 is common across OECD countries. A specific example is Britain before the Thatcher reforms of the labor market took place: Harrigan estimates that in 1980 TFP in the production of machinery and equipment was about three times larger in the US than Britain. Since these estimates are just for OECD countries, one expects considerably larger differences in sector TFP between OECD countries and developing countries. Note that sector-TFP differences of a factor 6.5 do not only come from using inefficient technologies but also from inefficient work practices. There is ample evidence that inefficient work practices alone can reduce productivity significantly. For example, Clark (1987) documents that in 1910 differences in work practices generated cross-country differences of a factor 7 in the labor productivity of cotton-textile mills. Schmitz (2001b) documents that in the 1980s the US and Canadian iron-ore industries doubled their labor productivities basically by changing their work rules.

The sixth column reports the ratios between aggregate TFP with monopoly and competition, where aggregate TFP is defined in expression (3.2). The model predicts that aggregate TFP with competition be 3 times larger than with monopoly. The estimates of Hall and Jones (1999) show that aggregate TFP differences of a factor of 2 to 3 are common, even though they control for human capital differences. For example, they estimate aggregate TFP differences between the US and India of a factor of 2.5 and between Italy and India of a factor of 2.9. Given that our model abstracts from human capital accumulation, differences in aggregate TFP of a factor 3 are well within reason.

Table 3: Different percentiles of countries
(c for competition, m for monopoly, p^* for international prices)

n	$\frac{Y(top\ n\%, p^*)}{Y(bot\ n\%, p^*)}$	$\frac{p_s(top\ n\%)}{p_s(bot\ n\%)}$	$\frac{Y(c, p^*)}{Y(m, p^*)}$	$\frac{5.\ column}{2.\ column}$
10	**30.4**	**7.7**	**10.8**	**0.35**
20	18.3	5.4	7.7	0.42
30	11.5	4.6	6.3	0.54
40	7.7	3.4	4.4	0.57

To establish the robustness of our results, we conduct sensitivity analysis with respect to the number of countries and the parameter values. With respect to the number of countries, we explore how the model's predictions change if we calibrate δ, α, A, and ω from the data of the richest and poorest 20, 30, and 40 percentiles of countries. In this exercise, we leave the other parameter values unchanged. The results are summarized in Table 3. The first column lists the percentiles considered, the second column lists the ratios of the per-capita income levels in the richest versus the poorest n percentiles, the third column list the ratios of the relative prices of services in the richest versus the poorest n–th percentiles, the fourth column lists the ratios of the per-capita income levels in model economy with competition versus monopoly, the last column lists the ratio of the fourth divided by the second column. The differences in income and in the relative price ratios fall as we take averages over more countries. However, the part of the income difference explained by the model (column six) rises considerably (from 35 to 57 percent). This suggests that our results are not specific to the richest and poorest 10 percentiles.

With respect to the parameter values, we explore how the model's predictions change if we change one parameter value at a time. Note that it does not make sense to change the values of A and μ because their chosen values are the only ones that make the units in the model coincides with those in the data. We find that our results are robust to changes in γ, ρ, β, δ, and α.[11] In contrast, Table 4 shows that the results are very sensitive to the choice of ω. This should not be interpreted as a weakness of the model though because ω measures the strength of monopoly power, and that is the key variable.

[11]The results are available upon request.

Table 4: Different monopoly power
(c for competition, m for monopoly, p^* for international prices)

ω	$\frac{p_s(c)}{p_s(m)}$	$\frac{Y(c,p^*)}{Y(m,p^*)}$	$\frac{I(c,p^*)}{Y(c,p^*)}$	$\frac{I(m,p^*)}{Y(m,p^*)}$	$\frac{TFP_z(c)}{TFP_z(m)}$
0.950	6.0	8.5	0.29	0.14	5.3
0.961	7.0	9.9	0.29	0.13	6.2
0.966	**7.7**	**10.8**	**0.29**	**0.12**	**6.7**
0.974	9.0	12.5	0.29	0.11	7.9
0.979	10.0	13.7	0.29	0.10	8.8

5 Discussion

Our modeling choices and results may raise some questions. The aim of this section is to anticipate and address the main ones.

Why have we attributed the cross-country difference in the relative price of services to monopoly rights? An alternative would have been to attribute it to a tax τ on the purchase of intermediate goods, which would have been in the spirit of what Chari et al (1996) and Restuccia and Urrutia (2001) do in a one-sector model. To answer this question, we now explore briefly the quantitative implications of such a tax. In this exercise, we can abstract from insiders and outsiders and assume that there is one representative individual with two units of time. The representative individual then solves:

$$\max_{\{s_t,\, m_t,\, k_{t+1},\, l_{st},\, l_{mt}\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t \frac{\left(s_t^{\alpha} m_t^{1-\alpha}\right)^{1-\rho} - 1}{1-\rho}$$

$$\text{s.t. } p_{st}s_t + p_{mt}m_t + p_{xt}[k_{t+1} + (\delta - 1)k_t] = r_t k_t + w_t(l_{st} + l_{mt}) + \pi_t + T_t,$$

$$s_t, m_t, k_{t+1}, l_{st}, l_{mt} \geq 0, \quad l_{st} + l_{mt} \leq 2, \quad k_0 > 0 \text{ given.}$$

l_{st} and l_{mt} are the amounts of time allocated to the service sector and the manufacturing sector, and T_t is the lump-sum rebate of the tax revenue on purchases of manufactured goods:

$$T_t = \tau \int_1^2 p_{z_i t} z_{it} di.$$

The problems of the representative firms are:[12]

$$\max_{s_t,\,k_{st},\,l_{st}} p_{st}Ak_{st}^{\theta}(\gamma^t l_{st})^{1-\theta} - r_t k_{st} - w_t l_{st} \quad \text{s.t.} \quad s_t, k_{st}, l_{st} \geq 0,$$

$$\max_{m_t,\,x_t,\,z_{it}} p_{mt}m_t + p_{xt}x_t - (1+\tau)\int_1^2 p_{z_it}z_{it}di$$

$$\text{s.t.} \quad \mu m_t + x_t = \left(\int_1^2 z_{it}^{\frac{\sigma-1}{\sigma}}di\right)^{\frac{\sigma}{\sigma-1}}, m_t, x_t, z_{it} \geq 0,$$

$$\max_{z_{it},\,k_{z_it},\,l_{z_it}} p_{z_it}z_{it} - r_t k_{z_it} - w_t l_{z_it} \quad \text{s.t.} \quad z_{it} = k_{z_it}^{\theta}(\gamma^t l_{z_it})^{1-\theta},$$

$$z_{it}, k_{z_it}, l_{z_it} \geq 0.$$

To solve the model with a tax, we follow the same steps as in the proofs of Propositions 1 and 2 in Appendix A. This yields $(1+\tau)p_{st}A = (1+\tau)p_{zt} = p_{mt}/\mu = p_{xt} = 1$, Equation (A.5) in Appendix A, and

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

Combining these equations, we can compute the equilibrium quantities as functions of the tax rate. We choose the tax rate such that the ratio of the prices of services relative to capital without and with the tax equals 7.7. Given a choice of θ, we again choose δ such that the model economy without taxes has an investment share of 0.23 measured in domestic prices. The results are reported in Table 5.

Table 5: Quantitative results tax economy

θ	$\frac{Y(0,p^*)}{Y(\tau,p^*)}$	$\frac{I(0,p^*)}{Y(0,p^*)}$	$\frac{I(\tau,p^*)}{Y(\tau,p^*)}$
0.3	3.8	0.29	0.06
0.35	4.7	0.29	0.06
0.4	**6.1**	**0.29**	**0.06**
0.45	8.3	0.30	0.06
0.59	29.4	0.29	0.06

Comparing Tables 2 and 5, we see two main differences: (i) monopoly reduces the level of income by much more than taxes; (ii) taxes reduce the investment share by much more than monopoly. Comparing the investment shares, we see that with monopoly they are much closer to the 11 percent in the data than with taxes. This provides support for our assumption that monopoly rights drive the cross-country difference in relative prices, and not taxes. Finally, comparing the last rows of Tables 2 and 5, we see that for a tax to generate the income level difference observed in the data, we would need an even higher

[12]Note that p_{zt} is the price the domestic firm gets for the domestic intermediate good in units of the foreign capital good. Thus, we have implicitly assumed that the domestic firms cannot export its production. Alternatively, we could assume that exports of the domestic firm are subject to the tax τ.

capital share than with monopoly rights. Interestingly, however, that capital share is still lower than what Mankiw et al (1992) and Chari et al (1996) needed (0.59 instead of 0.7).

The intuitive reasons for the differences between monopoly rights and a tax are as follows. Monopoly reduces the productivity in manufacturing and leads to over-staffing (ie all insiders work in manufacturing with monopoly), whereas taxes do not have these effects. Thus, monopoly has a larger effect on income. Taxes increase the relative price of capital for both sectors whereas monopoly increases the relative price of capital only for the service sector. Thus, taxes have a larger effect on the capital stock.

Why have we chosen to represent monopoly rights as in (2.4)? Ideally we would have modeled an entry game as Parente and Prescott (1999) do. Unfortunately, embedding such an entry game in the neoclassical growth model is too complicated when there is capital, so we chose a reduced-form of modeling monopoly rights. To gain some confidence in the robustness of our specification, we have considered two other formulations. The first formulation has outsiders and insiders produce with different capital stocks:

$$z_{it} = k_{z_i ot}^{\theta}[\gamma^t(1-\omega)l_{z_i ot}]^{1-\theta} + k_{z_i it}^{\theta}(\gamma^t b_{it} l_{z_i it})^{1-\theta}.$$

This could be the case, for example, if the entry of outsiders happened through the entry of new firms that hired only outsiders. This formulation does not make a difference for our results, so our choice is merely a matter of reducing notation. The second formulation has the coalition choose not only the insider productivity but also that of the outsiders:

$$z_{it} = k_{z_i t}^{\theta}\{\gamma^t b_{it}[(1-\omega)l_{z_i ot} + l_{z_i it}]\}^{1-\theta}.$$

This would be the case if the insiders had more monopoly power than in our specification. With this formulation the BGP equilibrium with monopoly becomes indeterminate. We prefer our specification because, as Proposition 2.3 proves, the BGP equilibrium is unique, and so comparative static exercises are well defined.

Why have we assumed that monopoly rights apply to manufacturing and not to services? The first reason is that having monopoly rights in services instead of in manufacturing would increase the relative price of services. Thus, the model would make the counterfactual prediction that poorer countries have higher relative prices of services. The second reason is that the production of manufactured goods is often more standardized and takes place on a larger scale than the production of service goods, making it easier for the workforce in manufacturing sectors to organize itself and lobby for monopoly rights. It should be mentioned that having monopoly rights in both manufacturing and services should strengthen our results. The reason is that the monopoly rights in services would increase the relative price of services, so the monopoly rights in manufacturing would have to be even stronger than in our model in order to generate the low observed relative price of services in poor countries.

Note that our environment also precludes the insider coalition from directly chosen the insider wage.

Finally, our results raise the question of why societies tolerate monopoly rights at the costs of substantial losses of income. Olson (1982) argues 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 and they have constructed equilibria in which monopoly rights are granted. 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 time consistent. Once a coalition has given up monopoly rights, society can tax away the transfers it paid to it in exchange or grant monopoly rights to a new coalition. Second, Kocherlakota (2001) showed that limited enforcement and sufficient inequality can imply that the allocation with monopoly rights is in fact constrained Pareto efficient, so a compensatory scheme does not exist.

6 Conclusions

We have asked which part of the observed cross-country differences in the level of per-capita income can be accounted for by monopoly rights in the labor market. We have constructed a growth model in which monopoly rights permit insider coalition to block the adoption of more efficient technologies or best-practice working arrangements. We have calibrated the model economy by assuming that the observed cross-country differences in the price of the non-tradable consumption good relative to capital goods come entirely from differences in the strength of monopoly in the intermediate good sector, which produce the inputs for the capital-producing manufacturing sector. We have demonstrated that monopoly rights can lead to quantitatively large reductions in the level of income. In particular, for our baseline calibration, the per-capita income level with competition is by a factor 10.8 larger than that with monopoly rights. This is 4 times the difference of 2.7 found by Parente and Prescott (1999) for a model economy without capital. We have also demonstrated that the calibrated model is consistent with the observation that compared to rich countries, poor countries face higher prices of capital relative to consumption, invest smaller output shares in international prices, and have lower total factor productivity. The key to these results is that monopoly rights in the intermediate goods sectors do not only reduce the insider productivity there, but also increase the relative price of capital and so reduce the capital-labor ratio in the whole economy.

Our paper is most closely related to Holmes and Schmitz (1995), Parente and Prescott (1999, 2000), and Herrendorf and Teixeira (2002), which study monopoly rights in the labor market but abstract from capital. It is also related to the branch of the development literature that seeks to account for the observed cross-country differences in per-capita incomes under the assumption that the most productive technology and work practices are freely available once developed. In particular, Mankiw et al (1992) emphasize the role of intangible capital, which increases the capital share; Chari et al (1996), Eaton and Kortum (2001), and Restuccia and Urrutia (2001) emphasize the role

of policy and trade distortions, which imply 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; Acemoglu and Robinson (2002) emphasize the role of political elites, who lose power when technological change takes place. We view these alternative explanations of differences in per-capita income levels as complementary to our own. Our results, nonetheless, distinguish monopoly rights by establishing quantitatively that they can greatly reduce per-capita income levels.[13]

We end by suggesting several directions for future research. First, we have assumed that each insider coalition is small relative to the aggregate economy. While this is a natural starting point, several economies (those in Scandinavia for instance) have economy-wide labor coalitions. This is important because an economy-wide coalition will take into account the effects of its productivity choice on aggregate variables such as relative prices and the real interest rate, and should therefore block less. A challenging task is to show this formally. Second, the existing evidence is exclusively micro-evidence that shows how monopoly rights lead to the use of inefficient technologies and working arrangements at the firm or sector level; see for example Parente and Prescott (1999, 2000), Holmes and Schmitz (2001a, b), 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 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 physical capital. Chari et al (1996) showed that broadening the concept of capital by including human capital increases the income level differences that tax distortions generate. We plan to similarly extend the present model economy by including human capital and exploring whether this feature further magnifies the effects of monopoly rights.

[13]The alternative explanations discussed in this paragraph all focus on income level differences. There is also a literature that studies how differences in institutional arrangements or policies affect growth rates. Recent examples are Hendricks (2000), who explores differences in equipment prices, Traca (2001), who explores differences in trade policy, and Edwards (2003), who explores differences in federal systems.

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A Appendix: Derivations and proofs of the propositions

First-order conditions

The first-order conditions to problem (2.1) are:

$$p_{st}s_{\iota t} = \alpha[(1+r_t-\delta)k_{\iota t} + w_{\iota t} - k_{\iota t+1}], \tag{A.1a}$$

$$p_{mt}m_{\iota t} = (1-\alpha)[(1+r_t-\delta)k_{\iota t} + w_{\iota t} - k_{\iota t+1}], \tag{A.1b}$$

$$\frac{(s_{\iota t})^{\alpha(1-\rho)}}{p_{mt}(m_{\iota t})^{\rho+\alpha(1-\rho)}} = \beta(1+r_{t+1}-\delta)\frac{(s_{\iota t+1})^{\alpha(1-\rho)}}{p_{mt+1}(m_{\iota t+1})^{\rho+\alpha(1-\rho)}}. \tag{A.1c}$$

The first-order conditions to problem (2.2) are:

$$r_t = p_{st}A\theta k_{st}^{\theta-1}(\gamma^t l_{st})^{1-\theta}, \tag{A.2a}$$

$$w_{it} \geq p_{st}A(1-\theta)k_{st}^{\theta}\gamma^{t(1-\theta)}l_{st}^{-\theta}, \quad \text{“=” if } l_{sit} > 0, \tag{A.2b}$$

$$w_{ot} = p_{st}A(1-\theta)k_{st}^{\theta}\gamma^{t(1-\theta)}l_{st}^{-\theta}. \tag{A.2c}$$

Given that $p_{mt} = \mu$, we can rewrite problem (2.3) to:

$$\max_{z_{it}} \left(\int_1^2 z_{it}^{\frac{\sigma-1}{\sigma}}di\right)^{\frac{\sigma}{\sigma-1}} - \int_1^2 p_{z_it}z_{it}di.$$

Therefore, the demand function for intermediate good z_i is given by:

$$z_{it} = \frac{1}{p_{z_it}^{\sigma}}\left(\int_1^2 z_{it}^{\frac{\sigma-1}{\sigma}}di\right)^{\frac{\sigma}{\sigma-1}}. \tag{A.2d}$$

Imposing zero profits gives:

$$1 = \int_1^2 p_{z_it}^{1-\sigma}di. \tag{A.2e}$$

The first-order conditions to the problem (2.4) are:

$$r_t = p_{z_it}\theta k_{z_it}^{\theta-1}(\gamma^t l_{z_it})^{1-\theta}, \tag{A.2f}$$

$$w_{it} = p_{z_it}(1-\theta)k_{z_it}^{\theta}\gamma^{t(1-\theta)}b_{it}l_{z_it}^{-\theta}, \tag{A.2g}$$

$$w_{ot} \geq p_{z_it}(1-\theta)k_{z_it}^{\theta}\gamma^{t(1-\theta)}(1-\omega)l_{z_it}^{-\theta}, \quad \text{“=” if } l_{sot} > 0. \tag{A.2h}$$

Proof of proposition 3.1

Existence of unique value functions

We will only report the proof for the representative insider. The one for the representative outsider follows the same steps. First, we transform the relevant variables by deflating them:[14]

$$\tilde{s}_{\iota t} \equiv \frac{s_{\iota t}}{\gamma^t}, \quad \tilde{m}_{\iota t} \equiv \frac{m_{\iota t}}{\gamma^t}, \quad \tilde{k}_{\iota t} \equiv \frac{k_{\iota t}}{\gamma^t}, \quad \text{etc.}$$

[14] Recall that $\iota \in \{o, i\}$ indicate the type of individual.

The indirect period utility of the representative insider can then be written as:

$$\begin{aligned}&\tilde{u}(\tilde{F}, b, \tilde{\tilde{k}}_i, \tilde{k}_i, \tilde{k}_i') \\ &= \tilde{\beta}^t \frac{\alpha^{\alpha(1-\rho)}(1-\alpha)^{(1-\alpha)(1-\rho)}\{\tilde{w}_i(\tilde{F}, b) + [1 + \tilde{r}(\tilde{F}) - \delta]\tilde{k}_i - \gamma \tilde{k}_i'\}^{1-\rho} - 1}{(1-\rho)[\tilde{p}_s(\tilde{F})]^{\alpha(1-\rho)}[\tilde{p}_m(\tilde{F})]^{(1-\alpha)(1-\rho)}}.\end{aligned}$$

Using this, the Bellman equation can be written as

$$\begin{aligned}&\tilde{v}_i(\tilde{F}, b, \tilde{\tilde{k}}_i, \tilde{k}_i) \\ &= \max_{0 \leq \tilde{k}_i' \leq \gamma^{-1}\tilde{w}_i(\tilde{F}, b) + [1 + \tilde{r}(\tilde{F}) - \delta]\tilde{k}_i\}} \{\tilde{u}(\tilde{F}, b, \tilde{\tilde{k}}_i, \tilde{k}_i, \tilde{k}_i') + \tilde{\beta}\tilde{v}_i(B', b', \tilde{\tilde{k}}_i', \tilde{k}_i') \\ \text{s.t. } &\tilde{F}' = \tilde{G}(\tilde{F}), \quad (b, \tilde{\tilde{k}}_i)' = (g_b, \tilde{g}_{ki})(\tilde{F}, b, \tilde{\tilde{k}}_i).\end{aligned}$$

Since there are decreasing marginal returns to capital and positive depreciation, there is some maximal sustainable capital stock, which we call $\hat{K}$. Define the set of possible values for the capital stock as $\mathcal{K} \equiv [0, max\{\tilde{K}_{i0} + \tilde{K}_{o0}, \hat{K}\}]$ and the set of possible states as

$$[0,1] \times \mathcal{K} \times \mathcal{K} \times [0,1] \times \mathcal{K} \times \mathcal{K}.$$

Furthermore, define a correspondence Γ that maps that set into itself and that describes the feasibility constraints by

$$\Gamma(\tilde{F}, b, \tilde{\tilde{k}}_i, \tilde{k}_i) = [0,1] \times \mathcal{K} \times \mathcal{K} \times [0,1] \times [0, \gamma^{-1}\{w_i(\tilde{F}, b) + [1 + \tilde{r}(\tilde{F}) - \delta]\tilde{k}_i\}]^2.$$

Γ so defined satisfy the assumptions of Chapter 4 of Stokey and Lucas (1989), so there exists a unique value function and a unique policy function.[15]

b = 1 in BGP equilibrium

The problem of the representative insider coalition boils down to the problem of maximizing the next period's utility of its representative member. Recall that $l_{zit} > 0$ and $l_{sot} > 0$ by assumption, so some outsiders labor must be allocated to the service sector and some insider labor must be allocated to the intermediate good sector.

We begin by showing that $b = 1$ is a BGP equilibrium strategy. If $b = 1$, then outsiders and insiders have the same marginal product in the intermediate good sector. Since they also have the same marginal product in the service sector, the wages in the service sector and the intermediate good sector must be the same. (If they were not, then all individuals would want to work in the sector with the higher wage, which is inconsistent with equilibrium.) Consider any deviation $b_t < 1$. Then the marginal outsider product in the intermediate good sector would be higher than that of the insiders. The first subcase would be that the outsiders are still indifferent between the service sector and the intermediate good sector. Since $l_{zit} > 0$ by assumption, some insiders would still work in the intermediate good sector. Since their marginal product there

[15] Note that for $\rho = 1$ the utility function reduces to $\log(s_t^{\alpha} m_t^{1-\alpha})$, which is not bounded from below. This is easily rectified in the standard way by switching to $\log(\epsilon + s_t^{\alpha} m_t^{1-\alpha})$ where $\epsilon > 0$ and small.

is smaller than that of the outsider, they would earn a lower wage than they could earn in the service sector. This is a contradiction. The second subcase would be that the outsider strictly prefer to work in the service sector. In this case, the insiders must be indifferent or prefer the intermediate good sector. Since the insiders marginal product in the intermediate good sector is lower than that of the outsiders, this would imply that all outsiders would prefer the intermediate good sector too. This is a contradiction.

Market clearing

We start by noting that the equality of the wages and the equality of the real interest rates across sectors imply the quality of the capital-labor ratios, which, in turn, implies that $p_s A = 1$. This together with the Euler equations (A.1c) gives the capital-labor ratios along the BGP equilibrium:

$$\frac{\tilde{K}_t}{2} = \frac{\tilde{K}_{st}}{L_{st}} = \frac{\tilde{K}_{zt}}{L_{zt}} = \left[\frac{\beta\theta}{\gamma^\rho + \beta(\delta - 1)}\right]^{\frac{1}{1-\theta}}. \tag{A.4}$$

Applying Walras law, we only need to prove market clearing for the manufacturing sector. The supply of manufactured consumption goods is given by the production minus the BGP investment:

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

The demand for manufactured consumption goods is given by $(1-\alpha)/\mu$ times the income that is spent on consumption goods. Recalling that $p_s A = 1$, we have:

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

Equalizing supply and demand and rearranging, we find:

$$\left(\frac{\tilde{K}_{zt}}{L_{zt}}\right)^{\theta} L_{zt} = (1-\alpha)\left[\left(\frac{\tilde{K}_{st}}{L_{st}}\right)^{\theta} L_{st} + \left(\frac{\tilde{K}_{zt}}{L_{zt}}\right)^{\theta} L_{zt}\right] + \alpha(\gamma+\delta-1)\left(\frac{\tilde{K}_t}{2}\right) 2. \tag{A.5}$$

Using (A.4) and that $L_{st} + L_{zt} = 2$, we obtain:

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

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

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

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 $\beta(1 - \delta) < 1 \leq \gamma^\rho$, this inequality always holds.

Existence of a unique BGP equilibrium

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 b_t is constant, it follows that the quantities of all goods grow at rate $\gamma - 1$ too.

Proof of proposition 3.2

Existence of unique value functions

The first part of the proof is to show that there are value and policy functions to the problems of the representative outsider and the representative insider. This part of the proof is basically the same as with competition and thus omitted.

Market clearing

We start by noting that we cannot apply the proof for $\omega = 0$. The reason is that for $\omega = 0$, the coalition chooses $b_t = 1$ and l_{zt} clears the market for manufactured goods. In contrast, in the postulated BGP equilibrium for $\omega > 0$ the outsiders are indifferent between the service sector and the intermediate good sector, we have $l_{zt} = 1$ and $p_{st}A = (1-\omega)^{1-\theta}$, so b_t clears the market. To see that $p_{st}A = (1-\omega)^{1-\theta}$, equalize the real returns on capital and on outsider labor across sectors:[16]

$$p_{st}A\theta\tilde{K}_{st}^{\theta-1} = \theta\tilde{K}_{zt}^{\theta-1}b_t^{1-\theta}, \tag{A.6a}$$

$$p_{st}A(1-\theta)\tilde{K}_{st}^{\theta} = (1-\theta)\tilde{K}_{zt}^{\theta}(1-\omega)b_t^{-\theta}, \tag{A.6b}$$

implying

$$\frac{\tilde{K}_{st}}{\tilde{K}_{zt}} = \frac{1-\omega}{b_t}. \tag{A.7}$$

Putting this equation back into (A.6), we obtain:

$$p_{st}A = (1-\omega)^{1-\theta}. \tag{A.8}$$

We now find $b_t \in (0,1)$ that clears the market. Using (A.7), (A.8), and the BGP conditions that the marginal products of the capital stocks in units of the z good are given by $\gamma^{\rho}\beta^{-1}+\delta-1$, we obtain the same expression for

[16] Tildes again denote variables deflated by γ^t.

the investment share as with competition. Moreover, we obtain the two BGP capital stocks:

$$\tilde{K}_{st} = (1-\omega)\left[\frac{\beta\theta}{\gamma^\rho + \beta(\delta-1)}\right]^{\frac{1}{1-\theta}}, \tag{A.9a}$$

$$\tilde{K}_{zt} = b_t\left[\frac{\beta\theta}{\gamma^\rho + \beta(\delta-1)}\right]^{\frac{1}{1-\theta}}. \tag{A.9b}$$

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

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

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

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

where we have used the fact that $M_t = Z_t$ in equilibrium. Equalizing supply and demand and using (A.9), we find that the market for the manufactured consumption good clears if and only if

$$\alpha\beta\theta(\gamma+\delta-1)[1+(1-\omega)b_t^{-1}] = [\alpha-(1-\alpha)(1-\omega)b_t^{-1}][\gamma^\rho+\beta(\delta-1)]. \tag{A.10}$$

If there is a solution to this equation, then it is time independent. Condition (A.9a) ensures that the left-hand side is smaller than the right-hand side when $b = 1$; Condition (A.9b) ensures that the left-hand side is larger than the right-hand side when $b = 1-\omega$. Thus, there is a constant market-clearing $\underline{b} \in (1-\omega, 1)$ for which the outsiders are just indifferent and the insiders strictly prefer the intermediate good sector. The uniqueness of this $\underline{b}$ follows because both sides of (A.10) change monotonically and in opposite directions when b changes.

$\mathbf{b}_t = \underline{\mathbf{b}}$ in BGP equilibrium

We start by deriving the semi reduced-forms of the wages. They will be functions of b_t, which the coalition chooses, of $\bar{l}_{zt}$, which the coalition affects because it is a sector-wide average, and of M_t, X_t, and r_t, which the coalition does not affect because they are economy-wide averages.

Substituting (A.2f) into (A.2g) and (A.2h), we find that the insider and outsider wages can be written as:

$$w_{it} = b_t(1-\theta)p_{zt}^{\frac{1}{1-\theta}}\left(\frac{\theta}{r_t}\right)^{\frac{\theta}{1-\theta}}\gamma^t, \tag{A.11a}$$

$$w_{ot} \geq (1-\omega)(1-\theta)p_{zt}^{\frac{1}{1-\theta}}\left(\frac{\theta}{r_t}\right)^{\frac{\theta}{1-\theta}}\gamma^t. \tag{A.11b}$$

Since the coalition affects p_{zt}, we need to eliminate it. To this end, combine the production function from (2.4) with (A.2d):

$$\bar{k}_{zt}^{\theta}(\gamma^t\bar{l}_{zt})^{(1-\theta)} = p_{zt}^{-\sigma}(\mu M_t + X_t),$$

implying that

$$p_{zt} = \frac{(\mu M_t + X_t)^{\frac{1}{\sigma}}}{\bar{k}_{zt}^{\frac{\theta}{\sigma}}(\gamma^t\bar{l}_{zt})^{\frac{1-\theta}{\sigma}}}. \tag{A.12}$$

Substituting this expression into (A.2f), we find:

$$\bar{k}_{zt} = \left[\frac{\theta^{\sigma}(\mu M_t + X_t)}{r_t^{\sigma}(\gamma^t\bar{l}_{zt})^{(1-\theta)(1-\sigma)}}\right]^{\frac{1}{\theta+\sigma(1-\theta)}}. \tag{A.13}$$

This expression together with (A.12) gives us the semi-reduced form for the relative price:

$$p_{zt} = [\theta^{-\theta}(\mu M_t + X_t)^{1-\theta}r_t^{\theta}(\gamma^t\bar{l}_{zt})^{-(1-\theta)}]^{\frac{1}{\theta+\sigma(1-\theta)}}. \tag{A.14}$$

The semi-reduced forms for the wages result after substituting (A.14) into (A.11a) and (A.11b):

$$w_{it} = \frac{(1-\theta)[\theta^{\theta(\sigma-1)}(\mu M_t + X_t)r_t^{\theta(1-\sigma)}]^{\frac{1}{\theta+\sigma(1-\theta)}}}{(\gamma^t\bar{l}_{zt})^{\frac{(1-\theta)(1-\sigma)}{\theta+\sigma(1-\theta)}}}, \tag{A.15a}$$

$$w_{ot} \geq \frac{(1-\omega)(1-\theta)[\theta^{\theta(\sigma-1)}(\mu M_t + X_t)r_t^{\theta(1-\sigma)}]^{\frac{1}{\theta+\sigma(1-\theta)}}}{b_t(\gamma^t\bar{l}_{zt})^{\frac{(1-\theta)(1-\sigma)}{\theta+\sigma(1-\theta)}}}. \tag{A.15b}$$

Recall that we showed in the market-clearing part that there is a unique $\underline{b}$ that clears markets and implies that the insiders strictly prefer the intermediate good sector and the outsiders are just indifferent. Now, we show that $\underline{b}$ is part of a BGP equilibrium, that is, deviating from it does not increase the insider wage. At $b_t = \underline{b}$, (A.15a) and (A.15b) reduce too:

$$w_{it} = \frac{(1-\theta)[\theta^{\theta(\sigma-1)}(\mu M_t + X_t)r_t^{\theta(1-\sigma)}]^{\frac{1}{\theta+\sigma(1-\theta)}}}{(\gamma^t\underline{b})^{\frac{(1-\theta)(1-\sigma)}{\theta+\sigma(1-\theta)}}}, \tag{A.16a}$$

$$w_{ot} = \frac{(1-\omega)(1-\theta)[\theta^{\theta(\sigma-1)}(\mu M_t + X_t)r_t^{\theta(1-\sigma)}]^{\frac{1}{\theta+\sigma(1-\theta)}}}{\underline{b}(\gamma^t\underline{b})^{\frac{(1-\theta)(1-\sigma)}{\theta+\sigma(1-\theta)}}}. \tag{A.16b}$$

We assume that the deviation is marginal so the insiders continue to prefer strictly the intermediate good sector. Consequently, insider labor continues to equal to one. (A.16a) shows that if the coalition increases b_t marginally, then w_{it} falls irrespective of how outsider labor reacts. If the coalition decreases b_t marginally, then w_{it} falls too. This follows because if outsider labor remained unchanged, then the right hand-side of (A.16b) would become larger than the service-sector wage w_{ot}. Since some outsiders must work in the service sector by assumption, outsiders labor in the intermediate good sector must go up until (A.15b) holds. But then the denominator of (A.15a) must increase because the denominator of (A.15b) remained unchanged. Thus, w_{it} falls.

$\underline{b}$ in each BGP equilibrium

We start by showing that $\tilde{\underline{b}} \in [0, \underline{b})$ cannot be part of an equilibrium. Suppose firstly that at $\tilde{\underline{b}}$ the outsiders strictly prefer the service sector or are just indifferent. The outsider marginal product in the intermediate good sector at $\tilde{\underline{b}}$ would then have to be larger than at $\underline{b}$ because $\tilde{\underline{b}} < \underline{b}$, $l_{zit} = \underline{b}$ at $\underline{b}$, and $l_{zit} \leq \underline{b}$ at $\tilde{\underline{b}}$. This is a contradiction because at $\underline{b}$ the outsiders are just indifferent. Suppose secondly that the outsiders are indifferent and that some outsiders work in the intermediate good sector. Increasing b_t marginally above $\tilde{\underline{b}}$, the outsiders must remain indifferent. By the same argument as in the previous paragraph, this increase must increase the insider wage.[17]

Next, we show that $\tilde{\underline{b}} \in (\underline{b}, 1]$ cannot be part of an equilibrium. Suppose firstly that at $\tilde{\underline{b}}$ the outsiders strictly prefer the service sector. If at $\tilde{\underline{b}}$ the insiders strictly prefer the intermediate good sector, then the same arguments as before show that the coalition can increase the insider wage by decreasing b_t. If at $\tilde{\underline{b}}$ the insiders are indifferent, then there must be a $b_t \in (0, \tilde{\underline{b}})$ for which the insiders are just indifferent and the outsiders still prefer the service sector strictly (recall that the outsiders' marginal product in the intermediate good sector is smaller than that of the insiders). Decreasing b_t marginally again increase the insider wage.

Suppose secondly that the outsiders are indifferent. If the insiders strictly prefer the intermediate good sector and the outsiders are just indifferent, we are in the equilibrium characterized above. If the insiders strictly prefer the intermediate good sector and the outsiders are indifferent so that outsider labor in the intermediate good sector is positive the same arguments as before imply that increasing b_t increases the insider wage. If the insiders are indifferent too, then $b_t = 1 - \omega$. Then increase b_t marginally. If the outsiders remain indifferent, then from (A.15) the insiders must strictly prefer their sector. Since the insiders were indifferent before, this must increase their wage. If the outsiders strictly prefer working in their sector, then they were just indifferent. But we showed din the market clearing part above that in this case $b_t > 1 - \omega$, so the insiders cannot be indifferent.

[17] Recall that we do not need to analyze the case that the outsiders strictly prefer the intermediate good sector because we have assumed that the outsider labor in the service sector is positive.

Existence of a unique BGP equilibrium

This part of the proof is exactly as in Proposition 3.1.

Proof of proposition of 3.3

Parts (c) of Propositions 3.1 and 3.2 imply that p_{st} is smaller with monopoly than with competition and that p_{st} falls as ω increases.

Using (3.3), the investment share in output measured in domestic prices can be expressed as:

$$\frac{\delta(K_{st}+K_{zt})}{p_{st}K_{st}^{\theta}(\gamma^t L_{st})^{1-\theta}+K_{zt}^{\theta}(\gamma^t L_{zt})^{1-\theta}}=\frac{\delta}{p_{st}}\left(\frac{K_{st}}{\gamma^t L_{st}}\right)^{1-\theta}=\frac{\beta\delta\theta}{\gamma^{\rho}+\beta(\delta-1)}. \quad \text{(A.17)}$$

Thus, the share in domestic prices is invariant to changes in ω. Denote the international price of services relative to capital by p_{st}^*. Note that for the monopoly economy $p_{st}^* > p_{st}$ and for the competition economy $p_{st}^* < p_{st}$. Consequently, with monopoly the investment share is smaller measured in international than in domestic prices; with competition the investment share is larger measured in international than in domestic prices. Moreover, since p_{st} falls as ω increases whereas p_{st}^* remains invariant, the investment share in international prices falls as ω increases.

Parts (b) of Propositions 3.1 and 3.2 imply that b_t is smaller with monopoly than with competition. Thus, TFP in the intermediate good sectors is smaller with monopoly than with competition. The market clearing condition (A.10) implies that $(1-\omega)b_t^{-1}$ is constant. Hence, b_t and TFP in the intermediate good sectors fall as ω increases.

The Euler equations (3.3) and the fact that p_{st} and b_t are smaller with monopoly than with competition imply that the capital-labor ratios in all sectors are smaller with monopoly than with competition. Moreover, since p_{st} and b_t fall as ω increases, the capital-labor ratios of all sectors fall as ω increases. Since aggregate labor is constant, the aggregate capital stock must be smaller with competition than with monopoly and it must fall as ω increases. The Euler equations (3.3) imply that total output equals:

$$p_{st}K_{st}^{\theta}L_{st}^{1-\theta}+K_{zt}^{\theta}L_{zt}^{1-\theta}=\frac{\beta\theta}{\gamma^{\rho}+\beta(\delta-1)}(K_{st}+K_{zt}). \quad \text{(A.18)}$$

Thus, total output is smaller with competition than with monopoly and it falls as ω increases.

Definition (3.2) and (A.18) imply that aggregate TFP can be written as

$$TFP=\frac{\beta\theta}{\gamma^{\rho}+\beta(\delta-1)}\left(\frac{K_{st}+K_{zt}}{2\gamma^t}\right)^{1-\theta}. \quad \text{(A.19)}$$

Thus, aggregate TFP is smaller with monopoly than with competition and it falls as ω increases.

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