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Barriers to Entry and Development

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Barriers to Entry and Development*

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Abstract: We ask whether barriers to entry are a quantitatively important reason for the income gap between developing countries and the U.S. We develop a tractable general equilibrium model that captures the effects of barriers to entry and the other main classes of distortion typically considered in the development literature. We carry our model to the data and ask it to match the main development facts from the Penn World Table. We find that this requires large barriers to entry in developing countries, which account for about half of the income gap between developing countries and the U.S.

Keywords: barriers to entry; monopoly power; rent extraction; total factor productivity.

JEL classification: EO0; EO4.

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1 Introduction

Perhaps the most challenging question in development economics is why some countries are so much poorer than the U.S. In their classic book, North and Thomas (1973) argued that barriers to entry prevent the development of poor countries because they give monopoly power to groups of individuals that would lose economic rents if better technologies and more productive working arrangements were adopted. These insider groups protect their rents by blocking the adoption of better technologies and more productive working arrangements, thereby preventing development.[2] In this paper, we ask whether large barriers to entry are a quantitatively important reason for the income gap between the poorest countries and the U.S.

The evidence on the existence of barriers to entry in poor countries goes back at least to de Soto (1989), who documented that Peru had large barriers to starting a formal business and suggested that this was an important reason for its poverty. Djankov et al. (2002) build a sample of 85 countries and confirmed de Soto's thesis that developing countries have much larger barriers to starting a formal business than developed countries. There is also evidence that even in richer countries barriers to entry have detrimental effects. In particular, in the OECD countries product market regulation is negatively related to investment [Alesina et al. (2003)] and TFP [Nicoletti and Scarpetta (2003)]. In both cases, barriers to entry are the dimension of product market regulation that has the biggest negative impact. Many industry case studies find similar results.[3]

To conclude, we have evidence that barriers to entry exist in poor countries and that they are harmful in richer countries. What is missing, however, is systematic direct evidence on how harmful barriers to entry are in poor countries. The reason is that the available data for these countries is very limited. In this paper, we develop a tractable

[2]Lindbeck and Snower (2001) define insiders as incumbent workers that enjoy more favorable employment opportunities than others (the outsiders), on account of labor turnover costs. Here we use insiders more generally to refer to individuals that are shielded from outsider competition by entry barriers.

[3]Examples are Clark (1987), Wolcott (1994), McKinsey Global Institute (1999), Holmes and Schmitz (2001a,b), Parente and Prescott (2000), Galdon-Sanchez and Schmitz Jr. (2002), Lewis (2004), and Schmitz Jr. (2005).

version of the growth model that captures the main effects of barriers to entry and that we can carry to the data to assess how harmful they are in poor countries. We emphasize that our exercise is not a sophisticated econometric analysis that provides direct evidence on the effects of barriers to entry. In contrast, our findings will depend on the version of the growth model that we employ. We nonetheless believe that given the data limitations, our exercise constitutes a useful first step that can help us to understand how harmful barriers to entry are quantitatively. We also emphasize that apart from the distortions that we will introduce, our model is a standard growth model that is typically used in the macro literature on development and structural transformation, and that has been shown to be consistent with many macro development facts.

Our model has an agricultural sector and many nonagriculture sectors ("manufacturing"). The agricultural sector produces agricultural consumption and the nonagricultural sectors produce manufactured consumption, intermediate goods, and capital. The agricultural sector uses the usual inputs land and labor along with intermediate inputs and capital from manufacturing. Since land is in fixed supply, the agricultural technology has decreasing returns to the reproducible factors. Preferences are such that the income elasticity of agricultural consumption is less than one ("Engel's Law").

The novelty of our work is to introduce barriers to entry and rent extraction by insider groups into this model. Examples for insider groups are labor or trade unions, professional associations, and castes in India.[4] We follow the development literature, e.g. Parente and Prescott (1999), and assume that barriers apply to entry into manufacturing whereas entry into agriculture is free. The reasoning behind this assumption is that many agricultural goods can be produced through subsistence farming, which makes it hard to erect barriers and establish monopoly power in the agricultural sector. We also assume that insider groups in the manufacturing sectors can choose the technologies or working arrangements, and that they can extract rents by deliberately choosing inefficient technologies or working arrangements.

[4]Munshi and Rosenzweig (2006) provide evidence how the caste system in India affects schooling choices and labor market outcomes.

Solving the rent–extraction problem of the insider groups is challenging because each group needs to take into account how the capital stock in its sector reacts to its choice of technology or working arrangements. In other words, the problem of each insider group is dynamic here. We characterize the solution to this problem and show that larger barriers to entry reduce total factor productivity (TFP henceforth) and the capital–labor ratio. This is consistent with the evidence reported by Nicoletti and Scarpetta (2003) and Alesina et al. (2003). To our knowledge, we are the first to construct a model that qualitatively accounts for this evidence.

The development literature has studied several distortions other than barriers to entry.[5] We argue that we can capture the effects of the most important distortions in a reduced–form way by introducing higher taxes, lower agricultural TFP, and lower efficiency units of labor, all compared to the U.S. We define taxes broadly to include actual taxes, but also bribes, side payments, and the like.[6] Reasons for lower agricultural TFP range from less fertile farm land and worse climate to less developed transportation systems.[7] Lower efficiency units of labor may reflect lower endowments of human capital or that dealing with inefficient bureaucracies, overwhelming regulation, and similar obstacles consumes time.

To take this model to the data, we assume that is the U.S. corresponds to the undistorted model economy, for which we use off–the–shelf parameter values to the extent possible. We then restrict barriers to entry and the other distortions so as to match quantitatively the cross–sectional variation in the main development statistics reported by the Penn World Tables 96 (PWT96 henceforth). A qualitative summary of these statistics is as follows: poor countries have larger shares of the workforce in agriculture than rich countries, larger shares of agricultural goods in consumption, smaller shares of investment in output, and higher relative prices of investment goods and food.

Our exercise leads to the following findings. First, to match the income gap between

[5] A recent example is Hsieh and Klenow (2007).

[6] See Restuccia and Urrutia (2001) and Herrendorf and Valentinyi (2006) for further discussion.

[7] See Herrendorf et al. (2009) on transportation and agricultural productivity.

the U.S. and the poorest countries, barriers to entry in the poorest countries need to be large. We find that removing them from the distorted model economy (while leaving the other distortions in place) closes about half of the income gap with the undistorted economy. We also find that the distorted model economy has relatively large taxes and low efficiency units of labor, each of which account for less than a quarter of the income gap with the undistorted economy. Lastly, we find that the distorted economy has low agricultural TFP, but that this accounts only for a small part of the income gap. These findings suggest that large barriers to entry are an important reason for why some countries are so poor.

Our findings are consistent with two additional pieces of evidence that we have not targeted directly. First, the reduction in income due to low endowments with efficiency units of labor in the distorted economy countries is close to what development studies typically attribute to low human capital.[8] This is remarkable because we do not use any information about cross–country differences in schooling. Second, the labor productivity gap between the distorted and the undistorted economy comes out many times larger in agriculture than in nonagriculture, although by far the most damaging distortion – barriers to entry – applies to nonagriculture. That the productivity gap in agriculture is much larger than in nonagriculture is consistent with a large body of evidence from the agricultural literature.[9]

Our paper contributes to the recent development literature that offers theories of cross–country differences in TFP and income.[10] It also contributes to the literature on the cost of monopoly. Harberger (1954) argued that this cost is small if monopoly just increases the price and reduces the quantity. While Laitner (1982) subsequently pointed out that the cost of monopoly can be larger when there is capital, he still estimated it to be a few percentage points of GDP only. More recently, Parente and Prescott

[8]See for example Hall and Jones (1999), Hendricks (2002), and Klenow (2006).

[9]Some classic references are Schultz (1964), Ruttan and Hayami (1970), and Kuznets (1971); some recent references are Caselli (2005) and Restuccia et al. (2006).

[10]Examples include Holmes and Schmitz (1995), Parente and Prescott (1999), Acemoglu and Robinson (2000), Acemoglu and Zilibotti (2001), Restuccia and Rogerson (2008), Amaral and Quintin (2004), Acemoglu (2005), Herrendorf and Teixeira (2005), Erosa and Hidalgo (2007), and Guner et al. (2006).

(1999) argued that monopoly can be much more detrimental if it also decreases TFP. Our work goes beyond that of Parente and Prescott (1999) in two crucial dimensions. First, we model capital accumulation whereas they used a static model without capital accumulation. While abstracting from capital accumulation simplifies matters, it does shut down an important channel through which the detrimental effects of monopoly get amplified. Second, except for the distortions, our model is a standard development model that we can carry to the data and that we can use to measure the costs of the monopoly power implied by barriers to entry. In contrast, the model of Parente and Prescott (1999) is more stylized and does not naturally lend itself to measurement.

The next section lays out the environment and section 3 defines the equilibrium. In section 4, we show existence and uniqueness of equilibrium and characterize the differences between the steady state equilibrium in the undistorted and the distorted economy. Section 5 describes our calibration and reports our findings. We conclude with a discussion of our modeling assumptions in section 6. An Appendix contains all proofs and some results from sensitivity analysis.

2 Environment

There are three final goods: an agricultural consumption good Y_a, a manufactured consumption good Y_m, and an investment good Y_x. There are also a continuum of intermediate goods Z_j with $j \in [0, 1]$. The agricultural sector produces the agricultural consumption good and the nonagricultural, or manufacturing, sectors produce the other goods. All technologies have constant returns to scale and each sector has a stand–in firm that behaves competitively.

We now specify the sector technologies.[11] The agricultural sector produces according

[11] Since in this project we are after differences in the *levels* of income, we will abstract from technological progress. This is as in Parente and Prescott (1999). We should mention that it would be straightforward to introduce technological progress into our model. However, this would not lead to substantial additional insights while it would complicate the notation further.

to:

$$(1) \qquad Y_a = A_a {K_a}^{\theta_k} L^{\theta_l} (\psi N_a)^{\theta_n} {Z_a}^{\theta_z}, \quad \text{where} \quad Z_a \equiv \left(\int_o^1 {Z_{ja}}^{\frac{\sigma-1}{\sigma}} dj \right)^{\frac{\sigma}{\sigma-1}}.$$

K_a, L, N_a, and Z_a are the capital, land, labor, and intermediate goods allocated to agriculture where L does not have the subscript a because we assume that only agriculture uses land. $\theta_k, \theta_l, \theta_n, \theta_z \in (0,1)$ are the corresponding share parameters with $\theta_k + \theta_l + \theta_n + \theta_z = 1$. $A_a \in (0,1]$ denotes agricultural TFP and $\psi \in (0,1]$ denotes the efficiency units of per unit of labor rented. We will vary both primitives across economies. σ denotes the elasticity of substitution between the intermediate goods.

The final manufacturing sector uses intermediate goods to produce the manufactured consumption good and the investment good according to:

$$Y_m = Z_m = \left(\int_o^1 {Z_{jm}}^{\frac{\sigma-1}{\sigma}} dj \right)^{\frac{\sigma}{\sigma-1}},$$
$$Y_x = A_x Z_x = A_x \left(\int_o^1 {Z_{jx}}^{\frac{\sigma-1}{\sigma}} dj \right)^{\frac{\sigma}{\sigma-1}}.$$

A_x is the TFP of producing investment goods from intermediate goods. Allowing it to be different from one will be useful for mapping the model into the data.[12]

Each intermediate good can be produced with two technologies that use capital and labor. The insider technology uses insider labor only whereas the outsider technology uses outsider labor only. The two production functions are given by:

$$(2a) \qquad Z_{ij} = A_{ij} {K_{ij}}^{\theta} (\psi N_{ij})^{1-\theta},$$

$$(2b) \qquad Z_{oj} = A_o {K_{oj}}^{\theta} (\psi N_{oj})^{1-\theta}.$$

Insider TFP $A_{ij} \in (0, \overline{A}]$ is specific to the insider technology in intermediate good sector

[12] We should point out that the assumption that the final manufacturing sector uses only intermediate inputs – but no labor and capital – is just a modeling device, which Parente and Prescott (1999) also used. This device ensures that each intermediate good remains small relative to the aggregate economy. Looking ahead a little, this is going to imply that the decisions made at the level of an intermediate good sector will not affect aggregate variables, which will be crucial.

j whereas the outsider TFP $A_o \in (0, \overline{A}]$ applies to all outsider technologies. We will vary A_{ij} and A_o across economies. Note that the quantities produced with the two technologies limit the use of intermediate inputs in the final good sectors:

$$Z_{ja} + Z_{jm} + Z_{jx} \leq Z_{ij} + Z_{oj}.$$

There is a measure one of households, which have identical preferences over sequences of the agricultural and the manufactured consumption good. We represent the preferences by a time–separable utility function $\sum_{t=0}^{\infty} \beta^t u(c_{at}, c_{mt})$ with a period utility from the Stone–Geary class:

$$u(c_a, c_m) = \alpha \log(c_a - \underline{c}) + (1 - \alpha) \log(c_m).$$

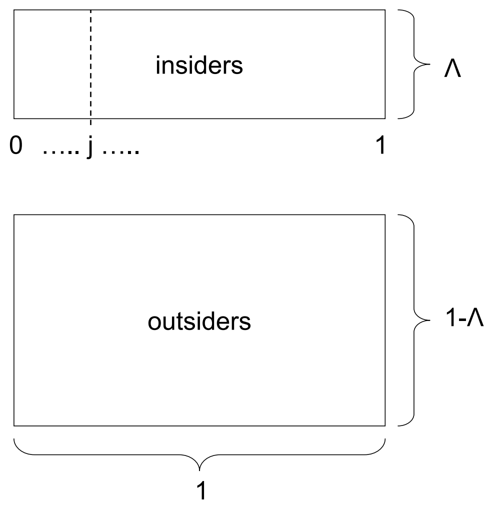
$\beta \in (0, 1)$ is the discount factor, c_a and c_m denote the consumption of the agricultural and the manufactured good, and $\alpha \in (0, 1)$ is a relative weight. The positive constant $\underline{c}$ implies that the income elasticity of agricultural consumption is smaller than one ("Engel's Law").

In the initial period households are endowed with shares l of the total available land and with strictly positive quantities b_o of capital, which depreciates at rate $\delta \in (0, 1)$. In each period households are also endowed with one unit of labor.

Households differ in their type: a measure $1 - \Lambda \in (0, 1)$ are outsiders and a measure Λ are insiders in one of the intermediate good sectors $j \in [0, 1]$. Λ will vary across economies. All outsiders are identical and there are equally many insiders in each intermediate–good sectors.[13] Figure 1 illustrates the resulting distribution of household types. The household type determines where the household can use its labor endowment. Specifically, the outsiders can transform their labor endowment into outsider labor services in any intermediate good sector and into labor services in agriculture. The insiders of type $j \in (0, 1)$ can transform their labor endowment into insider labor services in intermediate

[13] In other words the density over the insiders of the different intermediate good sectors is uniform.

Figure 1: Types



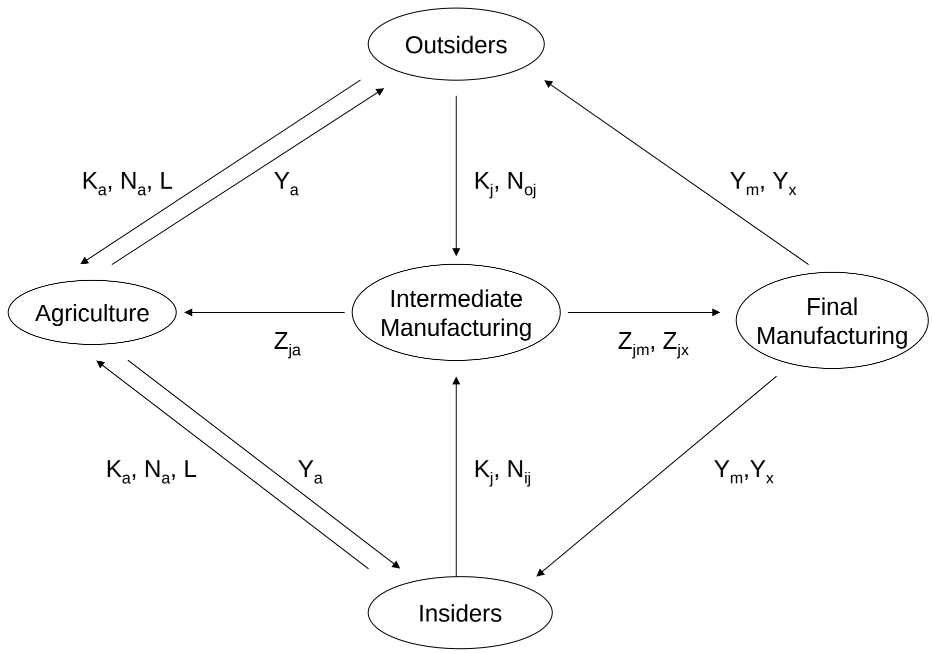
good sector j and into labor services in agriculture. Note that for simplicity we do not allow the insiders of type j to transform their labor endowment into outsider labor services in other intermediate good sectors $n \neq j$.

Figure 2 summarizes the key features of our environment. It shows that all households rent capital, K_a, labor N_a, and land, L, to the agricultural sector and capital, K_j, to the intermediate good sectors. The difference between outsiders and insiders is that the outsiders rent outsider labor, N_{oj}, to all intermediate good sectors whereas the insiders rent insider labor, N_{ij}, only to their intermediate good sector. All households purchase agricultural consumption goods, Y_a, from agriculture and manufactured consumption goods, Y_m, and investment goods, Y_x, from final manufacturing. The intermediate good sectors sell intermediate inputs Z_{ja} to agriculture and Z_{jm} and Z_{jx} to the final manufacturing sectors.

We consider cross–country differences in taxes τ_a, τ_x, and τ_z on agricultural consumption, investment, and intermediate goods as a possible reason why relative prices differ across countries. We lump sum rebate the tax revenues to the households. Taxes are broadly defined as any distortion that increases a relative price and leads to income for some agents. Examples are value–added taxes, tariffs, bribes, and rents from monopoly power other than those accruing in the labor markets of the intermediate good sectors.

We finish the description of the environment with the market structure. Trade takes place in sequential markets. In each period there are markets for both consumption goods, the investment good, capital, land, labor in agriculture, outsider labor, each type of insider labor, and each intermediate good.

Figure 2: Environment



3 Equilibrium Definition

3.1 Undistorted and distorted economy

As we have explained in the previous section, the following parameters vary across economies:

- $A_a, \psi \in (0, 1]$
- $A_o, A_{ij} \in (0, \overline{A}]$
- $\Lambda \in (0, 1)$

- $\tau_a, \tau_x, \tau_z \in (-\infty, \infty)$

The benchmark is the undistorted economy in which $A_a = \psi = 1$, $A_o = A_{ij} = \overline{A}$, $\Lambda = 0$, and $\tau_a = \tau_x = \tau_z = 0$. In the distorted economy, A_a summarizes everything that makes agriculture less efficient, for example less fertile farm land, worse climate, or less developed transportation systems.[14] ψ captures everything that reduces the efficiency units of labor per unit of working time. This includes not only the effects of lower human capital endowments but also those of inefficient bureaucracies or overwhelming regulation.

The difference between $\overline{A}$ and A_o summarizes the barriers that outsiders face when they enter the nonagricultural sectors. We express them as a share of output instead of a fixed entry cost to maintain constant returns. This could be derived in a more disaggregate environment where the outsiders pay a fixed cost to start operating a decreasing–returns–to–scale technology in an intermediate good sector. Note that entry barriers apply when households want to leave agriculture so as to enter nonagriculture. The reason is that most agricultural goods are easily produced in the unofficial economy or in subsistence farming. This should make it hard to erect barriers and establish monopoly power in the agriculture sector.

There are different interpretations for A_o. Caselli and Coleman (2001) argue that working in nonagricultural requires a minimum degree of human capital (e.g. literacy) that is not required in agriculture. Since we have assumed that all households in a given economy have the same ψ, A_o picks up that less educated outsiders may have a lower marginal product in nonagriculture than more educated insiders. Second, as discussed in the introduction, poor countries are plagued by many formal and informal barriers to entry. de Soto (1989), for example, gave a detailed account of the mindboggling variety of administrative steps and bureaucratic procedures required to start a formal business in Peru. In addition, there are accounts of many informal barriers to entry that result from the preferential treatment of insiders, for example in the form of subsidized credit.

[14] See Herrendorf et al. (2009) on transportation and agricultural productivity.

We assume that the insiders of each intermediate good sector can exploit the monopoly power resulting from the entry barriers by acting as a group: in each period the insiders of type j collectively chooses next period's TFP for its insider technology, $A_{ij}{}' \in [0, \overline{A}]$. This choice happens simultaneously with the other decisions. As Holmes and Schmitz (1995) and Parente and Prescott (1999), we assume away problems of coordination or free riding. The assumption that each insider group chooses TFP directly and without any cost is a convenient reduced form that represents any choice or lobbying effort that reduce TFP. Real–world examples include the blocking of new and more productive technologies and the stipulation of inefficient work practices or low effort. Concrete examples for the latter are the number of holidays, staffing requirements, task descriptions, the number of breaks, and monitoring procedures.[15]

Our specification is consistent with lower than possible TFP resulting from the use of inefficient technologies or from the inefficient use of a given technology. All that matters is that the frontier technology or the most efficient work rules and practices are available as public goods once the richest countries have innovated them.[16] All other countries can then adopt them without having to innovate them again. The assumption that adoption is costless simplifies matters but does not drive our result that insider groups choose lower than possible sector TFPs.

3.2 Definition

Before we go into the details of our equilibrium concept we sketch its broad features. We focus on symmetric equilibrium. This is natural here because all insiders solve identical problems, as do all outsiders and all insider groups. We also focus on recursive equilibrium in which all decision makers condition their actions in each period only on the observable state variables. Moreover, except for the choices of the insider groups, all agents behave

[15]Clark (1987), Wolcott (1994), McKinsey Global Institute (1999), Holmes and Schmitz (2001a,b), Parente and Prescott (2000), Galdon-Sanchez and Schmitz Jr. (2002), Lewis (2004), and Schmitz Jr. (2005) offer real–world examples of how these are used.

[16]Romer (1990) provides a model of endogenous growth through innovations. His model may be thought of as describing the technology leader who comes up with what the followers can adopt or block.

competitively. The choices of each insider group are strategic at the sector level in that it takes into account how its TFP choice affects the relative price of its intermediate good, the capital and labor allocated to its sector, and the consumption and investment choices of its members. In contrast, the insider groups take as given all *aggregate* variables. The reason is that the manufacturing sector is just a Dixit–Stiglitz aggregator of all intermediate good sectors, so each insider group is large only in its intermediate–good sector but small with respect to the rest of the economy.

We start with the description of the state variables.[17] Since we focus on symmetric equilibrium, all intermediate good sectors, insider types, and outsider types will each have the same equilibrium allocations. We therefore simplify our notation and drop the sector index j. We denote individual state variables by lower–case letters: b_i and b_o are the capital holdings of a particular insider in a particular intermediate good sector and of a particular outsider. We denote sector–wide state variables by upper case letters: the capital holdings of the other insiders of this sector are B_i and the insider TFP of this sector is A_i. We denote economy–wide state variables by upper–case calligraphic letters: $\boldsymbol{\mathcal{B}}_i$ are the capital holdings of the insiders in the other sectors, $\boldsymbol{\mathcal{B}}_o$ are the capital holdings of the other outsiders, and $\boldsymbol{\mathcal{A}}_i$ is the insider TFP in the other sectors.

In sum, the individual state is (b_i, b_o), the sector–wide state is (B_i, A_i), and the economy–wide state is $(\boldsymbol{\mathcal{B}}_i, \boldsymbol{\mathcal{B}}_o, \boldsymbol{\mathcal{A}}_i)$. The laws of motions of the sector–wide and economy–wide states are given by:

$$(B_i, A_i)' = G(\boldsymbol{\mathcal{B}}_i, \boldsymbol{\mathcal{B}}_o, \boldsymbol{\mathcal{A}}_i, B_i, A_i), \qquad \text{where } G = (G_1, G_2),$$

$$(\boldsymbol{\mathcal{B}}_i, \boldsymbol{\mathcal{B}}_o, \boldsymbol{\mathcal{A}}_i)' = \boldsymbol{\mathcal{G}}(\boldsymbol{\mathcal{B}}_i, \boldsymbol{\mathcal{B}}_o, \boldsymbol{\mathcal{A}}_i,), \qquad \text{where } \boldsymbol{\mathcal{G}} = (\boldsymbol{\mathcal{G}}_1, \boldsymbol{\mathcal{G}}_2, \boldsymbol{\mathcal{G}}_3).$$

To economize on the notation, we abbreviate some state variables: $S \equiv (B_i, A_i)$ and $\boldsymbol{\mathcal{S}} \equiv (\boldsymbol{\mathcal{B}}_i, \boldsymbol{\mathcal{B}}_o, \boldsymbol{\mathcal{A}}_i)$.

We choose manufactured consumption as the numeraire. The relative prices of agricultural goods and capital and the rental prices of outsider labor, capital, and land are

[17]The following material draws on Teixeira (1999).

functions of the aggregate state only: $p_a(\boldsymbol{\mathcal{S}})$, $p_x(\boldsymbol{\mathcal{S}})$, $w_o(\boldsymbol{\mathcal{S}})$, $r_k(\boldsymbol{\mathcal{S}})$, and $r_l(\boldsymbol{\mathcal{S}})$.[18] The relative price of a particular intermediate good and the rental price of a particular type of insider labor depend also on the insider TFP in the corresponding intermediate good sector: $p_z(\boldsymbol{\mathcal{S}}, A_i)$ and $w_i(\boldsymbol{\mathcal{S}}, A_i)$.

We are now ready for stating the households' problems. Recall that households can invest in any sector of the economy irrespective of whether they work there or not. Consequently the capital stock that the insiders own differs in general from the capital stock with which they produce. To emphasize this we have represented the two different capital stocks by the two different symbols B_i and K_i.

A particular outsider chooses his current consumption and future capital stock, taking as given the economy–wide state $\boldsymbol{\mathcal{S}}$, the corresponding law of motion $\boldsymbol{\mathcal{G}}$, and his own capital stock b_o:

$$
\begin{aligned}
(3) \qquad & v_o(\boldsymbol{\mathcal{S}}, b_o) = \max_{c_{oa}, c_{om}, b_o' \geq 0} \{u(c_{oa}, c_{om}) + \beta v_o(\boldsymbol{\mathcal{S}}', b_o')\} \\
& s.t.\ (1+\tau_a)p_a(\boldsymbol{\mathcal{S}})c_{oa} + c_{om} + (1+\tau_x)p_x(\boldsymbol{\mathcal{S}})[b_o' - (1-\delta)b_o] \\
& \qquad\qquad = r_k(\boldsymbol{\mathcal{S}})b_o + r_l(\boldsymbol{\mathcal{S}})l_o + w_o(\boldsymbol{\mathcal{S}}) + T_o(\boldsymbol{\mathcal{S}}), \\
& \boldsymbol{\mathcal{S}}' = \boldsymbol{\mathcal{G}}(\boldsymbol{\mathcal{S}}),
\end{aligned}
$$

where v_o denotes his value function and $T_o(\boldsymbol{\mathcal{S}})$ denotes the lump sum tax rebate to each outsider. The solution to this problem implies the outsider policy function (c_{oa}, c_{om}, b_o') $(\boldsymbol{\mathcal{S}}, b_o)$.[19]

A particular insider chooses his current consumption and future capital stock, taking as given the economy–wide state $\boldsymbol{\mathcal{S}}$, the corresponding law of motion $\boldsymbol{\mathcal{G}}$, its sector's state

[18] Note that in equilibrium the rental prices of outsider labor and labor in agriculture will be equal.

[19] Note that to economize on notation we have omitted profits. This is without loss of generality because constant returns and price–taking behavior imply that they are zero.

S, the corresponding law of motion G, and his own capital stock b_i:

$$(4)\quad v_i(\boldsymbol{\mathcal{S}}, S, b_i) = \max_{c_{ia}, c_{im}, b_i' \geq 0} \{u(c_{ia}, c_{im}) + \beta v_i(\boldsymbol{\mathcal{S}}', S', b_i')\}$$

$$s.t.\ \ (1+\tau_a)p_a(\boldsymbol{\mathcal{S}})c_{ia} + c_{im} + (1+\tau_x)p_x(\boldsymbol{\mathcal{S}})[b_i' - (1-\delta)b_i]$$

$$= r_k(\boldsymbol{\mathcal{S}})b_i + r_l(\boldsymbol{\mathcal{S}})l_i + w_i(\boldsymbol{\mathcal{S}}, A_i) + T_i(\boldsymbol{\mathcal{S}}),$$

$$(\boldsymbol{\mathcal{S}}, S)' = (\boldsymbol{\mathcal{G}}(\boldsymbol{\mathcal{S}}), G(\boldsymbol{\mathcal{S}}, S)),$$

where $T_i(\boldsymbol{\mathcal{S}})$ denotes the lump sum tax rebate to each insider. The solution to this problem implies the insider policy function $(c_{ia}, c_{im}, b_i')(\boldsymbol{\mathcal{S}}, S, b_i)$.

We continue with the problem of a particular insider group. Recall that while it takes all aggregate price functions and laws of motion as given, it takes into account how its TFP choice affects the relative price of its intermediate good, the capital and labor used with its insider technology, and the consumption and investment choices of its members. So, it chooses A_i' so as to maximize the indirect utility of its members plus the continuation value, taking as given the economy–wide state $\boldsymbol{\mathcal{S}}$, the corresponding law of motion $\boldsymbol{\mathcal{G}}$, the sector–wide state S, and the law of motion of the sector–wide insider capital, G_1:

$$(5)\qquad V_i(\boldsymbol{\mathcal{S}}, S) = \max_{A_i' \in [0, \overline{A}]} \{u((c_{ia}, c_{im})(\boldsymbol{\mathcal{S}}, S, B_i)) + \beta V_i(\boldsymbol{\mathcal{S}}', B_i', A_i')\}$$

$$s.t.\ \ (\boldsymbol{\mathcal{S}}, B_i)' = (\boldsymbol{\mathcal{G}}(\boldsymbol{\mathcal{S}}), G_1(\boldsymbol{\mathcal{S}}, S)).$$

A solution to this problem implies the policy function $A_i'(\boldsymbol{\mathcal{S}}, S)$.

We now turn to the sector allocation functions. All input factors and production quantities except for those of the intermediate good sector depend just on the aggregate state S: $(Y_a, K_a, L, N_a, Z_a)(\boldsymbol{\mathcal{S}})$, $(Y_m, Z_m)(\boldsymbol{\mathcal{S}})$, $(Y_x, Z_x)(\boldsymbol{\mathcal{S}})$. Those of the intermediate good sector depend also on insider TFP A_i: $(Z_i, K_i, N_i, Z_o, K_o, N_o)(\boldsymbol{\mathcal{S}}, A_i)$. Listing the supplies of the different goods on the left–hand sides and the demands on the right–hand sides, market clearing requires:

$$\text{(6a)} \quad Y_a(\boldsymbol{\mathcal{S}}) = (1-\Lambda)\, c_{oa}(\boldsymbol{\mathcal{S}}, b_o) + \Lambda\, c_{ia}(\boldsymbol{\mathcal{S}}, S, b_i),$$

$$\text{(6b)} \quad Y_m(\boldsymbol{\mathcal{S}}) = (1-\Lambda)\, c_{om}(\boldsymbol{\mathcal{S}}, b_o) + \Lambda\, c_{im}(\boldsymbol{\mathcal{S}}, S, b_i),$$

$$\text{(6c)} \quad Y_x(\boldsymbol{\mathcal{S}}) = (1-\Lambda)\, b_o'(\boldsymbol{\mathcal{S}}, b_o) + \Lambda\, b_i'(\boldsymbol{\mathcal{S}}, S, b_i) - (1-\delta)[(1-\Lambda)\, b_o + \Lambda\, b_i],$$

$$\text{(6d)} \quad Z_i(\boldsymbol{\mathcal{S}}, A_i) + Z_o(\boldsymbol{\mathcal{S}}, A_i) = Z_a(\boldsymbol{\mathcal{S}}) + Z_m(\boldsymbol{\mathcal{S}}) + Z_x(\boldsymbol{\mathcal{S}}),$$

$$\text{(6e)} \quad (1-\Lambda)\, b_o + \Lambda\, b_i = K_a(\boldsymbol{\mathcal{S}}) + K_o(\boldsymbol{\mathcal{S}}, A_i) + K_i(\boldsymbol{\mathcal{S}}, A_i),$$

$$\text{(6f)} \quad N_i(\boldsymbol{\mathcal{S}}, A_i) \leq \Lambda, \qquad N_o(\boldsymbol{\mathcal{S}}, A_i) \leq 1-\Lambda,$$

$$\text{(6g)} \quad 1 - N_i(\boldsymbol{\mathcal{S}}, A_i) - N_o(\boldsymbol{\mathcal{S}}, A_i) = N_a(\boldsymbol{\mathcal{S}}),$$

$$\text{(6h)} \quad (1-\Lambda) l_o + \Lambda l_i = L(\boldsymbol{\mathcal{S}}).$$

The first three conditions require that the markets for the two consumption goods and for investment clear. The fourth condition requires that the market for a particular intermediate good clears, and the fifth condition requires that the market for capital clears. The next two conditions require that the markets for the different types of labor clear. The last condition requires that the market for land clears.[20]

We continue with the consistence requirements that have to hold in equilibrium. To begin with, the economy–wide states, the sector–wide states, and the individual states need to be consistent with each other:

$$\text{(7a)} \quad \boldsymbol{\mathcal{A}}_i = A_i,$$

$$\text{(7b)} \quad \boldsymbol{\mathcal{B}}_i = B_i = b_i,$$

$$\text{(7c)} \quad \boldsymbol{\mathcal{B}}_o = b_o.$$

The laws of motion that the decision makers take as given when they make their choice

[20]Note that in symmetric equilibrium we can drop the integrals. Note too that we have abstracted from borrowing and lending between insiders and outsiders. This is without loss of generality because below we focus attention on steady state equilibrium.

need to be consistent with their policy functions:

$$\boldsymbol{\mathcal{G}}_1(\boldsymbol{\mathcal{S}}) = G_1(\boldsymbol{\mathcal{S}}, \boldsymbol{\mathcal{B}}_i, \boldsymbol{\mathcal{A}}_i) = b_i{}'(\boldsymbol{\mathcal{S}}, \boldsymbol{\mathcal{B}}_i, \boldsymbol{\mathcal{A}}_i, \boldsymbol{\mathcal{B}}_i), \tag{7d}$$

$$\boldsymbol{\mathcal{G}}_2(\boldsymbol{\mathcal{S}}) = b_o{}'(\boldsymbol{\mathcal{S}}, \boldsymbol{\mathcal{B}}_o), \tag{7e}$$

$$\boldsymbol{\mathcal{G}}_3(\boldsymbol{\mathcal{S}}) = G_2(\boldsymbol{\mathcal{S}}, \boldsymbol{\mathcal{B}}_i, \boldsymbol{\mathcal{A}}_i) = A_i{}'(\boldsymbol{\mathcal{S}}, \boldsymbol{\mathcal{B}}_i, \boldsymbol{\mathcal{A}}_i). \tag{7f}$$

Moreover the value function of the insider group needs to consistent with the value function of the particular insider:

$$V_i(\boldsymbol{\mathcal{S}}, \boldsymbol{\mathcal{B}}_i, \boldsymbol{\mathcal{A}}_i) = v_i(\boldsymbol{\mathcal{S}}, \boldsymbol{\mathcal{B}}_i, \boldsymbol{\mathcal{A}}_i, \boldsymbol{\mathcal{B}}_i). \tag{7g}$$

Finally the lump sum rebates need to equal the tax revenues:

$$T_o(\boldsymbol{\mathcal{S}}) = \tau_z p_z(\boldsymbol{\mathcal{S}}) Z_a(\boldsymbol{\mathcal{S}}) + \tau_a p_a(\boldsymbol{\mathcal{S}}) c_{oa}(\boldsymbol{\mathcal{S}}, \boldsymbol{\mathcal{B}}_o) + \tau_x p_x(\boldsymbol{\mathcal{S}})[b_o{}'(\boldsymbol{\mathcal{S}}, \boldsymbol{\mathcal{B}}_o) - (1-\delta) b_o], \tag{7h}$$

$$\begin{aligned} T_i(\boldsymbol{\mathcal{S}}) = {} & \tau_z p_z(\boldsymbol{\mathcal{S}}) Z_a(\boldsymbol{\mathcal{S}}) \\ & + \tau_a p_a(\boldsymbol{\mathcal{S}}) c_{ia}(\boldsymbol{\mathcal{S}}, \boldsymbol{\mathcal{B}}_i, \boldsymbol{\mathcal{A}}_i, \boldsymbol{\mathcal{B}}_i) + \tau_x p_x(\boldsymbol{\mathcal{S}})[b_i{}'(\boldsymbol{\mathcal{S}}, \boldsymbol{\mathcal{B}}_i, \boldsymbol{\mathcal{A}}_i, \boldsymbol{\mathcal{B}}_i) - (1-\delta) b_i]. \end{aligned} \tag{7i}$$

Definition 1 (Equilibrium in the undistorted economy) *An equilibrium in the undistorted economy is*

– *price functions* p_a, p_z, p_x, w_o, w_i, r_k, r_l

– *sector allocation functions* (Y_a, K_a, L, N_a, Z_a), (Y_m, Z_m), (Y_x, Z_x), $(Z_i, K_i, N_i, Z_o, K_o, N_o)$

– *laws of motion* $(\boldsymbol{\mathcal{G}}, G)$

– *value functions* v_o, v_i

– *policy functions* $(c_{oa}, c_{om}, b_o{}')$, $(c_{ia}, c_{im}, b_i{}')$

such that:

– *all production factors are paid their marginal products*

– *the value functions satisfy* (3)–(4)

– *the policy functions solve* (3)–(4)

– *the market clearing conditions* (6) *hold*

– *the consistency requirements* (7) *are satisfied.*

Definition 2 (Equilibrium in the distorted economy) *An equilibrium in the distorted economy is*

– *price functions* p_a, p_x, p_z, w_o, w_i, r_k, r_l

– *tax rebate functions* T_o, T_i

– *sector allocation functions* (Y_a, K_a, L, N_a, Z_a), (Y_m, Z_m), (Y_x, Z_x), $(Z_i, K_i, N_i, Z_o, K_o, N_o)$

– *laws of motion* $(\boldsymbol{\mathcal{G}}, G)$

– *value functions* v_o, v_i, V_i

– *policy functions* $(c_{oa}, c_{om}, b_o{}')$, $(c_{ia}, c_{im}, b_i{}')$, $A_i{}'$

such that:

– *if a production factor is used in a sector, then it is paid its marginal value product; if a production factor is not used in a sector, then its marginal value product does not exceed its rental rate;*

– *the value functions satisfy* (3)–(5)

– *the policy functions solve* (3)–(5)

– *the market clearing conditions* (6) *hold*

– *the consistency requirements* (7) *are satisfied.*

4 Steady State Equilibrium: Existence, Uniqueness, and Characterization

We now show the existence and uniqueness of the steady–state equilibria in both economies and we characterize the differences between them. Since our utility function features a subsistence level of agricultural consumption $\underline{c}$, existence of equilibrium requires that the agricultural sector can produce this subsistence level. Conditions (21a) and (23b) in the appendix ensure this for the undistorted and distorted economy, respectively.

Proposition 1 (Steady–state equilibrium in the undistorted economy)
Let condition (21a) *be satisfied. Then there exists a unique steady state equilibrium.*

Proof. See Appendix A.2.

In the distorted economy existence of steady–state equilibrium also requires that the insider groups are not too large and the upper bound $\overline{A}$ on the insider productivity is not too small. The two inequalities of (23c) in the appendix ensure that this is the case.

Proposition 2 (Steady–state equilibrium in the distorted economy)
Let the elasticity of substitution between the intermediate be inelastic: $\sigma \in (0, 1)$. *Moreover, let conditions* (23b) *and* (23c) *be satisfied.*

- *There exists a unique steady state equilibrium.*
- *In the steady–state equilibrium the insiders work only in their intermediate good sectors, and they strictly prefer this; the outsiders work only in agriculture, and they are indifferent between this and working in the intermediate good sectors.*
- *The steady–state equilibrium value of* A_i *lies in* $[A_o, \overline{A}]$*; it decreases if* A_o *decreases or if* Λ *increases.*

Proof. See Appendix A.3.

To build some intuition for these results, it may be helpful to consider for a moment a monopolist producer in an intermediate sector. Since we assumed that demand is inelastic here, $\sigma \in (0, 1)$, such a monopolist would restrict production and increase the relative price of the intermediate good above the competitive one until potential entrants would just be indifferent between entering and staying out.

The difference between a monopolist and an insider group is that the latter cannot *directly* choose a higher relative price or restrict production of its intermediate good because its good is produced by competitive firms. However, by choosing a lower TFP the insider group can *indirectly* choose a higher relative price. With inelastic demand, this increases the relative price by more than it decreases the insiders' marginal product, so it increases the insider marginal value product. The monopoly power is limited by the possible entry of outsiders into its intermediate goods sector. If entry occurs, then the relative price must be such that the outsider marginal value product is the same in the intermediate good sector and in agriculture. Choosing an even lower TFP then decreases the marginal insider product, but it does not affect the relative price anymore. This decreases the insider marginal value product and makes the insiders worse off. Taking these two arguments together, it follows that each insider group chooses A_i' such that the outsiders are just indifferent between entering into its intermediate good sector and staying out.

Clearly, this reasoning only applies if the demand for the insider group's output is inelastic, that is, σ needs to be between zero and one. It is important to realize, however, that the precise value of σ does not matter for our results, as long as σ stays within $(0, 1)$. The reason is that as long as the demand is inelastic, each insider group will find it optimal to increase the price of its output until entry occurs. One may wonder how realistic the assumption of inelastic demand is. After all, at the finest possible level of disaggregation there must be intermediate goods that are close substitutes. However, as one aggregates to coarser and coarser levels, the intermediate goods become less and less substitutable. Restricting σ to be between zero and one therefore amounts to assuming that insiders who seek to extract rents form groups at a sufficiently aggregate level such that there are no close substitute to their output.

We can also provide some intuition for the comparative static results of proposition 2. To begin with, the lower is A_o the larger is the relative price of intermediate goods that makes the outsiders indifferent between working in agriculture and the intermediate–good sector. Since choosing a lower A_i' increases p_i as long as the outsiders strictly prefer agriculture, a lower A_o makes choosing a lower A_i' optimal. Turning to the comparative statics of the group size, larger insider groups can produce a given demand for their product with lower A_i'. So a larger Λ decreases the optimal choice of A_i'. Note that these arguments are related to the necessary conditions for existence, (23c), which require that

$\overline{A}$ is large enough and Λ is not too large. The first condition ensures that the insider groups can satisfy the demand for their product when they choose $A_i = \overline{A}$ and the second condition ensures that the insiders do not produce more than the demand for their product when they choose $A_i = A_o$.

The result that larger barriers to entry (a smaller A_o) reduce the TFP of the intermediate goods sectors is consistent with a large body of evidence. To begin with, in a panel of OECD countries Nicoletti and Scarpetta (2003) found that product market regulation is negatively related to TFP. Importantly, barriers to entry are the dimension of product market regulation that has the biggest negative impact. Nickell (1996) found that more competition in UK sector led to higher TFP growth. Many case studies confirm these findings for many industries in developed and developing countries; see for example Clark (1987), Wolcott (1994), McKinsey Global Institute (1999), Holmes and Schmitz (2001a,b), Parente and Prescott (2000), Galdon-Sanchez and Schmitz Jr. (2002), Lewis (2004), and Schmitz Jr. (2005).

For the quantitative work that follows it is important to realize that entry barriers have potentially large indirect effects, in addition to their direct effect on the TFP of the intermediate good sectors. The first indirect effect works through the capital–labor ratios in the intermediate good sectors. Equation (14e) of Appendix A.1 shows that they decrease in A_i:

$$\text{(8a)} \qquad \frac{K_i}{\Lambda} = A_i^{\frac{1}{1-\theta}} \psi \left[\frac{A_x \beta \theta}{(1+\tau_x)[1-\beta(1-\delta)]} \right]^{\frac{1}{1-\theta}} .$$

Since A_i decreases when A_o decreases larger barriers lower the capital–labor ratio in the intermediate good sectors. The second indirect effect works through the relative prices of capital and intermediate goods. Larger barriers increase these relative prices, which reduces the capital–labor ratio and the intermediates–labor ratio in agriculture.

Equations (16b) and (16c) of Appendix A.1 show this formally:

$$\text{(8b)} \qquad \frac{K_a}{1-\Lambda} = A_o^{\frac{1}{1-\theta}} \psi \, \frac{\theta_k(1-\theta)}{\theta_n \theta} \left[\frac{A_x \beta\theta}{(1+\tau_x)[1-\beta(1-\delta)]} \right]^{\frac{1}{1-\theta}},$$

$$\text{(8c)} \qquad \frac{Z_a}{1-\Lambda} = A_o^{\frac{1}{1-\theta}} \psi \, \frac{\theta_z(1-\theta)}{\theta_n (1+\tau_z)} \left[\frac{A_x \beta\theta}{(1+\tau_x)[1-\beta(1-\delta)]} \right]^{\frac{\theta}{1-\theta}}.$$

Putting (8a) and (8b) together, we can also obtain an expression for the aggregate capital–labor ratio in the distorted economy:

$$\frac{K}{N} = K = \psi \left[\Lambda A_i^{\frac{1}{1-\theta}} + (1-\Lambda) A_o^{\frac{1}{1-\theta}} \frac{\theta_k(1-\theta)}{\theta_n \theta} \right] \left[\frac{A_x \beta\theta}{(1+\tau_x)[1-\beta(1-\delta)]} \right]^{\frac{1}{1-\theta}}.$$

In sum larger barriers (a smaller value of A_o) reduce the capital–labor ratio in all sectors and in the aggregate. This is consistent with the evidence reported by Alesina et al. (2003). A similar amplification mechanism is present in the work of Schmitz (2001), who argued that if the government produces investment goods inefficiently, then this reduces the labor productivity of all sectors that use these investment goods. Schmitz found sizeable effects on income of around a factor 3.

5 Quantitative Analysis

As we wrote in the introduction, we do not have sufficient data available for the poorest countries to provide systematic econometric evidence on how harmful barriers to entry are there. In the quantitative analysis that follows, we will therefore follow a different approach and use our model economy to measure the effects of barriers to entry. We emphasize that apart from the distortions that we have introduced, our model is a standard growth model that is typically used in the macro literature on development and structural transformation, and that has been shown to be consistent with many macro development facts. We therefore view our exercise as a useful first step that we hope will be complemented by future empirical work on how harmful barriers to entry are.

To impose discipline on our exercise, we will restrict the undistorted economy to match key statistics from the U.S. economy and the distorted economy to match key statistics from the poorest countries in the Penn World Tables. Once that is achieved, we will eliminate barriers to entry from the distorted economy while keeping the other distortions in place. We will use the resulting increase in income of the distorted economy as a measure of how harmful barriers to entry are. We should point out that we could also have followed a different approach, namely, to introduce barriers to entry into the otherwise undistorted economy and measure by how much income goes down. We did not follow this approach here because it is hard to impose discipline on it, given that we have little data only on the size of barriers to entry and of insider groups in the poorest countries.

5.1 Calibration

We map the undistorted economy into the U.S., which has relatively small distortions and it is the biggest and most studied developed economy. We map the distorted economy into the aggregate of the 30 poorest countries in the 1996 Benchmark Data of the Penn World Tables (PWT96 henceforth). We choose these 30 countries because the poorest 25 percent of the sample population live in them.[21] We calibrate to the aggregate of these 30 countries instead of country by country because we will use data from the PWT96 and the Food and Agricultural Organization (FAO) that is not available for all 30 poorest countries of the PWT96.

Table 1: Individually calibrated parameters

β	δ	θ	θ_k	θ_l	θ_n	θ_z	A_x	τ_x	Λ	L^{PC}	L^{US}
0.94	0.06	0.33	0.13	0.14	0.26	0.47	1.3	2.2	0.36	0.44	1.4

We start with the model parameters for which off–the–shelf values are available. We

[21]From poorest to richest, they are: Tanzania, Malawi, Yemen, Madagascar, Zambia, Mali, Tajikistan, Nigeria, Benin, Sierra Leone, Mongolia, Kenya, Congo, Bangladesh, Nepal, Senegal, Vietnam, Pakistan, Cote d'Ivoire, Cameroon, Moldova, Azerbaijan, Bolivia, Uzbekistan, Kyrgyzstan, Armenia, Guinea, Syria, Sri Lanka, and Albania.

follow Cooley and Prescott (1995) and set $\beta = 0.943$ and $\delta = 0.06$. For the factor shares in agricultural gross output, we combine information from Mundlak (2005) about the land share in the U.S. with information from the input–output tables for the U.S. as published by the BEA. This leads us to set $\theta = 0.33$, $\theta_k = 0.13$, $\theta_l = 0.14$, $\theta_n = 0.26$, $\theta_z = 0.47$.

We continue with parameter values that we calibrate individually. With regards to A_x and τ_x, we use that $p_x = 1/A_x$ in the undistorted model economy and $p_x = (1+\tau_x)/A_x$ in the distorted model economy. In the PWT96 the price of investment relative to manufacture consumption equals 0.76 for the U.S. and 2.4 for the poor country. Thus we set $A_x = 1.3$ and $\tau_x = 2.2$. We calibrate the land endowments, l, and the size of the insider groups, Λ, from data provided by the Food and Agricultural Organization (2004). Aggregating over these 24 countries, we find for the poor country that the ratio of arable land to the active population is 0.44 and the share of the active population in agriculture is 64%. Since the total active population has measure one in our model, we set $\Lambda = 1 - N_a^{PC} = 0.36$ and $L^{PC} = 0.44$. Following a similar logic, we set $L^{US} = 1.4$ for the U.S. Table 1 summarizes the parameter values that we calibrate individually.

Recalling that $A_a = 1$ for the undistorted economy, we have eight more parameters to calibrate: α, $\underline{c}$, ψ, $\overline{A}$, A_o, A_a, τ_a, τ_z. Our strategy is to choose them so as to match the following eight development facts from the PWT96: the income difference between the U.S. and the poor country; the shares of agricultural consumption in total consumption measured in international dollars in the U.S. and the poor country; the shares of investment in GDP measured in international dollars in the U.S. and the poor country; the share of the active population in agriculture in the U.S.; the domestic relative prices of agriculture in the U.S. and the poor country. Note that since we match the relative prices in the U.S., units in our model are equal to those in the PWT96. Consequently, we can use the international relative prices from the PWT96 when we evaluate model quantities in international prices.

We should briefly discuss why we can identify the effects of the different distortions. To begin with, low agricultural TFP and a tax on agricultural consumption both increase

Table 2: Jointly calibrated parameters

α	$\underline{c}$	ψ	$\overline{A}$	A_o	A_a	τ_a	τ_z
0.09	0.004	0.52	0.25	0.04	0.32	0.24	1.5

the price of agricultural goods. Since the tax revenues get rebated though, only low agricultural TFP has a direct income effect. Second, low endowments with efficiency units affect the efficiency of both agriculture and nonagriculture, as do low sector TFPs. But the effects of low endowments work through the amounts of labor services that are allocated to the two sectors, and so they depend on the sectoral labor shares, which are different. Third, we do not have enough information to tell whether the higher relative price of capital is due to taxes or to lower TFP in producing capital. We therefore give taxes the benefit of the doubt and assume that they are solely responsible for that relative price being higher. This should go against barriers to entry being important quantitatively.

Table 3 summarizes the values of our targets where Y_c stands for total consumption in international prices. The first part refers to targets that we use for the individual calibration and the second part refers to targets that we use for the joint calibration. We can see the common regularities: the poor country has a much larger share of agricultural consumption, a much smaller share of investment, and larger relative prices of agricultural goods and investment. Except for the cross–country difference in the relative price of agricultural goods, these regularities are well known; see for example Heston and Summers (1988), Easterly (1993), Jones (1994), Restuccia and Urrutia (2001), and Herrendorf and Valentinyi (2006).

We choose the parameter values that minimize the percentage difference between the eight target values in the data and the model. Table 2 reports the calibrated parameter values. The calibration implies that the insiders choose a smaller value of A_i than possible:

$A_i = 0.14$. To put the calibration results into perspective, note that

$$\frac{A_o}{\overline{A}} = 0.16, \qquad \frac{A_o}{A_i} = 0.29, \qquad \frac{A_a}{1} = 0.32.$$

In other words, outsider TFP in the intermediate–good sectors is 16 percent of the maximum possible TFP. Moreover, if the outsider entered, then they would produce with 29 percent of the insider TFP, that is, with the same capital and labor inputs they would produce a little less than a third of the output that the insiders would produce. This corresponds to large barriers to entry in the distorted economy. On might ask how realistic such larger barriers to entry are. Although we do not have much direct evidence on the size of barriers to entry into the manufacturing sectors of poor countries, we know from Djankov et al. (2002) that only the legal costs of setting up a formal business can easily exceed one per capita GDP in poor countries. Given credit constraints, the vast majority of people living in these countries will never be able to pay such costs. Another example of prohibitively high entry costs is the caste system in India where it is literally impossible for outsiders to become an insider.[22]

There are also large taxes in the poor country: more than 20% on agricultural output, 150% on intermediate inputs to agriculture, and more than 200% on investment goods. Furthermore, the agricultural TFP of the distorted economy is around 30% of that in the undistorted economy and the efficiency units of labor are around 50% of those in the undistorted economy. The large differences between the undistorted and the distorted economy suggest that all of four distortion may play important roles in accounting for the income difference between the U.S. and the poor country. In the next subsection, we will explore how large these roles are.

[22]See Munshi and Rosenzweig (2006) and the reference therein for further discussion. We thank an anonymous referee for this example.

Table 3: **Targets for individual calibration (PC for poor country)**

	${\frac{p_x}{p_m}}^{US}$	${\frac{p_x}{p_m}}^{PC}$	${\frac{L}{N}}^{US}$	${\frac{L}{N}}^{PC}$	${N_a}^{PC}$
Data = Model	0.76	2.4	1.4	0.44	0.36

Targets for joint calibration

	$\frac{Y^{US}}{Y^{PC}}$	${\frac{Y_a}{Y_c}}^{US}$	${\frac{Y_a}{Y_c}}^{PC}$	${\frac{Y_x}{Y}}^{US}$	${\frac{Y_x}{Y}}^{PC}$	${N_a}^{US}$	${\frac{p_a}{p_m}}^{US}$	${\frac{p_a}{p_m}}^{PC}$
Data	17.7	0.14	0.42	0.21	0.12	0.03	0.65	2.1
Model	18.8	0.14	0.37	0.20	0.07	0.03	0.66	2.1

5.2 Findings

We start by decomposing the income difference between the distorted and the undistorted economy into the parts due to different distortions. We are also interested in the implied cross-country differences in the aggregate capital–labor ratio and in aggregate TFP. We calculate aggregate TFP as the residual that would result if final output was produced according to an aggregate Cobb–Douglas production function with capital share θ:

$$Y_a + Y_m + Y_x = A\,(K_a + K_i)^{\theta}.$$

Adopting this definition of TFP from the growth–accounting literature (instead of using our model to derive aggregate TFP) allows us to compare our results with those obtained by that literature.

To decompose the cross–country differences, we take the distorted economy and first eliminate barriers to entry, then we increase agricultural TFP to the U.S. level, then we increase efficiency units, and lastly we eliminate taxes. Note that we must eliminate barriers to entry first because condition (23c) for the existence of equilibrium would be violated if we first eliminated the other distortions. The reason is that without the other distortions the economy is so rich and the share of manufactured consumption is so large that the insiders groups of given size cannot produce the demand for intermediate goods even if they choose $A_i = \overline{A}$. Note also that removing barriers to entry first measures both the direct and the indirect effects where the indirect effects arise from the interaction of barriers to entry with the other distortions.

Table 4: Decomposition of the aggregate differences (U for undistorted and D for distorted economy)

Distortions	$\frac{Y^U}{Y^D}$	$\frac{A^U}{A^D}$	$\frac{\frac{K}{N}^U}{\frac{K}{N}^D}$
No distortions	1.0	1.0	1.0
Taxes only	1.9	1.1	5.7
Taxes, efficiency units only	3.6	1.6	10.9
Taxes, efficiency units, agr. TFP only	4.1	1.9	10.9
Taxes, efficiency units, agr. TFP, barriers	18.8	5.0	55.9

Table 4 reports that the direct and indirect effects of barriers to entry account for 52 percent of the total income difference.[23] Higher taxes and lower efficiency units of labor account for 22 percent each while lower agricultural TFP accounts only for 4 percent of the income gap with the U.S. Interestingly our finding for the effect of lower efficiency units in the poor country is close to what development–accounting studies find for the implications of low endowment of human capital; see for example Hall and Jones (1999), Hendricks (2002), and Klenow (2006). This is remarkable because our calibration strategy does not use any information about cross–country differences in years of schooling, from which these studies construct their measures of human capital. The fact that nonetheless our findings are broadly in line with their estimates lends support to the view that unmeasured quality differences in human capital are not large.[24]

Table 4 also reports that barriers to entry account for most of the cross–country dif-

[23] Since the effects are multiplicative this follows by taking logs:

$$\frac{\log(18.8) - \log(4.1)}{\log(18.8)} = 0.52.$$

[24] Erosa et al. (2007) and Manuelli and Seshadri (2005) have recently taken the opposite view.

ference in aggregate TFP A. Moreover, barriers to entry together with low agricultural TFP account for almost the whole cross–country difference in aggregate TFP. One implication of this is that taxes must affect the aggregate economy mainly through reducing the capital–labor ratio. Indeed, the table shows that the cross–country difference in taxes account for a sizeable part of the cross–country difference in the capital–labor ratio.

Table 5: Decomposition of the sectoral differences (U for undistorted and D for distorted economy)

Distortions	$\frac{\frac{Y_a}{N_a}^U}{\frac{Y_a}{N_a}^D}$	$\frac{\frac{Y_i}{N_i}^U}{\frac{Y_i}{N_i}^D}$	$\frac{\frac{Z_a}{N_a}^U}{\frac{Z_a}{N_a}^D}$	$\frac{\frac{K_a}{N_a}^U}{\frac{K_a}{N_a}^D}$
No distortions	1.2	1.0	1.0	1.0
Taxes only	3.1	1.8	4.5	5.7
Taxes, efficiency units only	5.6	3.4	8.7	10.9
Taxes, efficiency units, agr. TFP only	19.6	3.4	8.7	10.9
Taxes, efficiency units, agr. TFP, barriers	121.5	8.2	122.7	154.5

The agricultural literature emphasizes that at the sector level the largest labor–productivity gap between the poor countries and the U.S. occurs in agriculture; see for example Restuccia et al. (2006). At first sight, this contradicts our finding that barriers to entry in nonagriculture account for about half of the income gap with the U.S. Table 5 reports that the labor productivity differences in our model nonetheless come out more than fifteen times larger in agriculture than in nonagriculture. Moreover, barriers to entry into nonagriculture drive most of the uneven cross–country differences in sectoral labor productivity: without them the productivity gap with the U.S. in agriculture is only about 6 times larger than in nonagriculture; with them the gap is an impressive 15 larger.[25]

There are two main reasons why our model generates so large labor productivity differences in agriculture. The first one is that the fixed factor land implies that the returns

[25]Note that the magnitudes of our numbers are hard to relate to those of Restuccia et al. (2006) because their data set is from 1985 and it does not contain many of the 34 economies that make up our poor country. Note too that even if there are no distortions there remains a small labor productivity difference in agriculture. This comes from the fact that the poor country has a lower land endowment than the US.

to the reproducible production factors in agriculture are decreasing. So if a majority of the population in poor countries produces food close to the required subsistence level, then the land–labor ratio will be low in agriculture. The second reason is that in our model barriers to entry reduce the ratios of intermediate goods to labor and of capital to labor in agriculture, as we discussed at the end of section 4.

5.3 Robustness

One may wonder how robust our findings are to the specific parameter choices that we made. To address this concern, we have conducted extensive sensitivity analysis. It turns out that our findings are not very sensitive to our parameter choices. This conclusion may come as a surprise particularly with regard to the intermediate good share in agriculture. After all, having an intermediate good share of 0.47% as in the U.S. forces the agricultural sector in the poorest countries to spend large amounts of resources on intermediate goods that have a high relative price. In Appendix B we therefore report the findings of our model when we reduce the intermediate good share from 0.47 to 0.3 or 0.1. The tables in the Appendix show that our main finding remains unchanged: removing barriers to entry from the distorted economy closes around half of the income gap between the U.S. and the poorest countries.

We think that the intuition for the robustness of our results with respect to different values of the intermediate good shares is closely related to the fact that there are constant returns in agriculture. This implies that if we decrease the intermediate good share, then we must increase the shares of the other factors of production in agriculture to maintain constant returns. In other words, a lower intermediate goods share goes along with higher capital and land shares. This leads to two offsetting effects. First, a higher capital share implies that the agricultural sector uses more capital, which also has a high relative price. Second, a higher land share implies that the agricultural sector has more strongly decreasing returns to the reproducible factors of production.

6 Discussion

In this section we discuss our modeling choices.

6.1 Monopoly power only in the labor market

Our rent–extraction mechanism is a special case. The general case would have monopoly power in both the goods and the labor market, so rents would go to both firms/entrepreneurs and workers. In terms of modeling, this would come at the costs of having several parameters, which would be messy and hard to discipline using the existing evidence. Examples of the general case (and its problems) are Cole and Ohanian (2004) and Spector (2004). Our special case has the monopoly power only in labor market, so rents go to workers only. This has the advantage of having just two parameters (the entry barriers A_o and the size of the insider group Λ), which is simple and can be calibrated. Examples of our special case (and its advantages) are Holmes and Schmitz (1995) and Parente and Prescott (1999). In sum, the reason for using our simple rent extraction mechanism is that it is parsimonious and analytically tractable while delivering that barriers to entry lead to economic rents and low TFP.

6.2 Insider groups cannot choose wages or hours worked

In our model the insider groups can choose TFP, but not wages or hours worked. We could incorporate a wage choice as in Parente and Prescott (1999) without changing any of our results. We leave it out because this would complicate our analysis further. In contrast, it is restrictive to assume that the insider groups cannot choose how much time the insiders work. If they could, then they could restrict their sectors' outputs by choosing low insider working time and high insider TFP. If leisure is a normal good, then this would lead to higher insider utility than reducing sector TFP [Cozzi and Palacios (2003)].

We nonetheless abstract from the choice of hours worked because there is no evidence that hours worked in developing countries are systematically lower than in the OECD countries. If anything, the opposite seems to be true. Given the evidence that there are insider groups in developing countries, they do not seem to succeed at collectively reducing their members' hours worked by substantial amounts. Moreover, Clark (1987), Wolcott (1994), McKinsey Global Institute (1999), and Parente and Prescott (2000) provide evidence that rent extraction in developing countries happened through the choice of inefficient work rules and practices, and not through reductions in hours worked.

To be sure, in a few European countries insider groups succeeded at collectively reducing their members hours worked. In particular, Prescott (2004) documents that France has much lower hours worked and higher labor productivity than the U.S. This outcome requires a close cooperation between centralized labor unions and the government. Even in the U.S., trade unions have never reached a similar degree of centralization as in France. One should therefore expect that rent extraction in the U.S. has not happened through reductions in hours. Holmes and Schmitz (2001a,b), Galdon-Sanchez and Schmitz Jr. (2002), and Schmitz Jr. (2005) document various case studies where indeed rent extraction has instead happened through labor unions choosing inefficient work rules and practices. The rent extraction process in most developing countries seems too chaotic to replicate even U.S. outcomes, so it is not surprising that insider groups there do not seem to succeed at reducing the hours worked by their members.

6.3 Insider groups stay together forever

Since we study steady-state equilibrium we find it natural to assume that the insider groups stay together forever. We emphasize that the duration of insider groups is not crucial for our results though. The reason is that each insider group's problem boils down to choosing the sector TFP that maximizes the insider wage in the next period; see appendix A.3.1. So one period is the minimum duration of insider groups required for our results. In what follows we suggest two alternative specifications in which the insider groups last exactly one period.

The first alternative would be to assume that in each period the members of the different insider groups are randomly chosen among all the insiders. Since in symmetric steady state equilibrium all insiders are identical, each insider group would still only need to know the average capital holdings of its members to maximize their utility. Thus, nothing would change.

The second alternative would be to assume that in each period the members of the insider groups are randomly chosen from the whole population. The individual capital holdings would then depend on how many times each individual has been chosen to be an insider in the past, so we would have a distribution of individual capital holdings. Besides complicating the notation greatly (and being pretty unrealistic), this would not matter for our results either. The first reason is that our preferences allow for aggregation, so the distribution of individual capital holdings would not have any effect on the aggregates of consumer choices. The second reason is that, as each insider group's problem boils down to maximizing insider wage income, the distribution of capital holding would not matter.

6.4 Why don't societies buy the insider groups out?

Rent extraction through inefficient work rules and practices leads to substantial losses of income. This raises the question why the outsiders in our model do not buy out the insider groups. Our model remains silent on how insider groups originate and disappear, so it cannot address buy outs. Taking the distortion as given without explaining its origin is common practice in the part of the growth and development literature that explores the implications of distortions. We view this as a useful first step in identifying the most damaging distortions, given that they exist in the real world.

The next step is to understand how the distortions can emerge and why they can persist. This requires an altogether different modeling approach that brings out political economy forces at the cost of the quantitative richness of the model economy. In this line of research, Krussel and Ríos-Rull (1996) and Bridgeman et al. (2007) made some progress on the question why barriers emerge. They formalized the argument of Olson (1982) that if the costs of erecting barriers to entry to each industry are small, then they will be erected. In Krussel and Ríos-Rull (1996) this works through voting whereas in Bridgeman et al. (2007) this works through lobbying. Unfortunately, both of these models are still far too stylized to be carried too the data.

We would also like to understand why society cannot buy out insider groups through compensatory schemes. The literature offers two answers. Parente and Prescott (1999) argued informally that compensatory schemes are not time consistent: once barriers to entry have been removed, society can tax away the compensatory transfers it paid to the groups or erect new barriers to entry. Kocherlakota (2001) showed in a stylized static model that limited enforcement and sufficient inequality can imply that a Pareto–improving compensatory scheme does not exist. More work is needed to formalize these arguments in a dynamic setting that can be carried to the data.

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Appendix: Derivations and Proofs

We will keep the notation to a minimum. Only if crucial for the argument will we mention how the endogenous variables depend on the state variables.

A.1 Equilibrium Conditions

A.1.1 Households' first–order conditions

Recalling that each household is endowed with l units of land and a unit of labor, we can write the problem of a household as:[26]

$$\begin{aligned} &\sum_{t=0}^{\infty} \beta^t [\alpha \log(c_{at} - \underline{c}) + (1-\alpha)\log(c_{mt})] \\ \text{s.t.} \quad &(1+\tau_a)p_{at}c_{at} + c_{mt} + (1+\tau_x)p_{xt}x_t = r_{kt}b_t + r_{lt}l + w_t + T_t, \\ &x_t = b_{t+1} - (1-\delta)b_t, \\ &b_o, l > 0 \text{ given.} \end{aligned}$$

The two static first–order conditions determine the composition of consumption:

$$\begin{aligned} (1+\tau_a)p_a c_a &= \alpha c + (1-\alpha)(1+\tau_a)p_a\underline{c}, \\ c_m &= (1-\alpha)c - (1-\alpha)(1+\tau_a)p_a\underline{c}, \end{aligned}$$

where c is the income that the household spends on consumption:

$$c \equiv (1+\tau_a)p_a c_a + c_m.$$

Aggregation across all household types implies:

$$(1+\tau_a)p_a Y_a = \alpha C + (1-\alpha)(1+\tau_a)p_a\underline{c}, \tag{9a}$$

$$Y_m = (1-\alpha)C - (1-\alpha)(1+\tau_a)p_a\underline{c}, \tag{9b}$$

[26] Note that the endowment, the wage, the allocation, and the tax rebate depend on the household's type. To keep the notation simple we leave this implicit and dropped the type index.

where

$$\text{(9c)} \quad C = r_k[(1-\Lambda)B_o + \Lambda B_i] + r_l L + [(1-\Lambda)w_o + \Lambda w_i] + \tau_a p_a Y_a + \tau_z p_z Z_a - p_x Y_x.$$

For future reference, we should mention that (9) has a unique solution for α and $\underline{c}$ if we observe $(\tau_a^{US}, \tau_a^{poor}, p_a^{US}, p_a^{poor}, Y_a^{US}, Y_a^{poor}, C^{US}, C^{poor})$:

$$\text{(10a)} \quad \alpha = \frac{Y_a^{US} - Y_a^{poor}}{\frac{C^{US}}{(1+\tau_a^{US})p_a^{US}} - \frac{C^{poor}}{(1+\tau_a^{poor})p_a^{poor}}},$$

$$\underline{c} = \frac{Y_a^{poor} - \alpha C^{poor}/[(1+\tau_a^{poor})p_a^{poor}]}{1-\alpha}$$

$$\text{(10b)} \quad = \frac{\frac{C^{poor}}{(1+\tau_a^{poor})p_a^{poor}} \frac{C^{US}}{(1+\tau_a^{US})p_a^{US}} \left[\frac{Y_a^{poor}}{C^{poor}/[(1+\tau_a^{poor})p_a^{poor}]} - \frac{Y_a^{US}}{C^{US}/[(1+\tau_a^{US})p_a^{US}]}\right]}{\frac{C^{US}}{(1+\tau_a^{US})p_a^{US}}\left[1 - \frac{Y_a^{US}}{C^{US}/[(1+\tau_a^{US})p_a^{US}]}\right] - \frac{C^{poor}}{(1+\tau_a^{poor})p_a^{poor}}\left[1 - \frac{Y_a^{poor}}{C^{poor}/[(1+\tau_a^{poor})p_a^{poor}]}\right]}.$$

It is easy to see that if the income elasticity of agricultural goods is smaller than one, then these expressions are well defined, that is, $\alpha \in (0,1)$ and $\underline{c} > 0$.

We now turn to the Euler equation. Aggregating across household types, we obtain

$$\frac{1}{Y_{mt}}(1+\tau_x)p_{xt} = \frac{\beta}{Y_{mt+1}}[(1+\tau_x)p_{xt+1}(1-\delta) + r_{kt+1}].$$

In steady–state equilibrium, this reduces to:

$$\text{(11)} \quad r_k = (1+\tau_x)p_x \frac{1-\beta(1-\delta)}{\beta}.$$

A.1.2 Firms' first–order conditions

Agriculture. The marginal value products in agriculture satisfy:

$$r_k = \theta_k p_a A_a \psi^{\theta_n} {K_a}^{\theta_k - 1} L^{\theta_l} {N_a}^{\theta_n} {Z_a}^{\theta_z}, \tag{12a}$$

$$r_l = \theta_l p_a A_a \psi^{\theta_n} {K_a}^{\theta_k} L^{\theta_l - 1} {N_a}^{\theta_n} {Z_a}^{\theta_z}., \tag{12b}$$

$$w_i \geq \theta_n p_a A_a \psi^{\theta_n} {K_a}^{\theta_k} L^{\theta_l} {N_a}^{\theta_n - 1} {Z_a}^{\theta_z}, \quad \text{“=”if } N_{ia} > 0, \tag{12c}$$

$$w_o \geq \theta_n p_a A_a \psi^{\theta_n} {K_a}^{\theta_k} L^{\theta_l} {N_a}^{\theta_n - 1} {Z_a}^{\theta_z}, \quad \text{“=” if } N_{oa} > 0, \tag{12d}$$

$$(1+\tau_z) p_{zj} = \theta_z p_a A_a \psi^{\theta_n} {K_a}^{\theta_k} L^{\theta_l} {N_a}^{\theta_n} {Z_a}^{\theta_z - 1} \left(\frac{Z_a}{Z_{ja}} \right)^{\frac{1}{\sigma}}. \tag{12e}$$

(11) and (12a) imply that

$$(1+\tau_x) p_x \frac{1-\beta(1-\delta)}{\beta} = \theta_k p_a A_a \psi^{\theta_n} {K_a}^{\theta_k - 1} L^{\theta_l} {N_a}^{\theta_n} {Z_a}^{\theta_z}. \tag{12f}$$

Using that $p_{zj} = p_z$ and $Z_{ja} = Z_a$ in symmetric equilibrium, dividing (12e) by (12f), and solving for K_a/Z_a, we find

$$\frac{K_a}{Z_a} = \frac{\theta_k}{\theta_z} \frac{(1+\tau_z) p_z}{(1+\tau_x) p_x} \frac{\beta}{1-\beta(1-\delta)}. \tag{12g}$$

Moreover, imposing that $Z_{ja} = Z_a$, (12e) implies that

$$p_a = \frac{(1+\tau_z) p_z {Z_a}^{1-\theta_z}}{\theta_z A_a \psi^{\theta_n} {K_a}^{\theta_k} L^{\theta_l} {N_a}^{\theta_n}}. \tag{12h}$$

Manufacturing. The first–order conditions for intermediate good j in final manufacturing are:

$$\left(\frac{Z_m}{Z_{jm}} \right)^{\frac{1}{\sigma}} = p_{zj},$$

$$p_x A_x \left(\frac{Z_x}{Z_{jx}} \right)^{\frac{1}{\sigma}} = p_{zj}.$$

Solving for Z_{jm} and Z_{jx}, we obtain:

$$Z_{jm} = \left(\frac{1}{p_{zj}}\right)^{\sigma} Z_m, \tag{13a}$$

$$Z_{jx} = \left(\frac{p_x A_x}{p_{zj}}\right)^{\sigma} Z_x. \tag{13b}$$

Note that in symmetric equilibrium this simplifies to:

$$1 = p_z = p_x A_x,$$

or

$$p_x = \frac{1}{A_x}.$$

Intermediate goods. In symmetric equilibrium, all intermediate good sectors are the same, so we can drop the sector index. The marginal value products in a particular intermediate good sector satisfy:

$$r_k \geq \theta p_z A_i \psi^{1-\theta} \left(\frac{K_i}{N_i}\right)^{\theta-1}, \qquad \text{“=” if } K_i, N_i > 0, \tag{14a}$$

$$w_i \geq (1-\theta) p_z A_i \psi^{1-\theta} \left(\frac{K_i}{N_i}\right)^{\theta}, \qquad \text{“=” if } K_i, N_i > 0, \tag{14b}$$

$$r_k \geq \theta p_z A_o \psi^{1-\theta} \left(\frac{K_o}{N_o}\right)^{\theta-1}, \qquad \text{“=” if } K_o, N_o > 0, \tag{14c}$$

$$w_o \geq (1-\theta) p_z A_o \psi^{1-\theta} \left(\frac{K_o}{N_o}\right)^{\theta}, \qquad \text{“=” if } K_o, N_o > 0. \tag{14d}$$

Using that $p_z = 1$ and $p_x = 1/A_x$ in equilibrium, (11), (14a), and (14c) imply that if the insider and outsider technology are operated in symmetric equilibrium, then:

$$K_i = \psi \left(\frac{A_i \varphi}{1+\tau_x}\right)^{\frac{1}{1-\theta}} N_i, \tag{14e}$$

$$K_o = \psi \left(\frac{A_o \varphi}{1+\tau_x}\right)^{\frac{1}{1-\theta}} N_o, \tag{14f}$$

where

$$\varphi \equiv \frac{A_x \beta\theta}{1-\beta(1-\delta)}. \tag{14g}$$

Thus, in symmetric equilibrium the intermediate goods that are produced with the two different technologies are:

$$Z_i = A_i^{\frac{1}{1-\theta}} \psi \left(\frac{\varphi}{1+\tau_x}\right)^{\frac{\theta}{1-\theta}} N_i, \tag{15a}$$

$$Z_o = A_o^{\frac{1}{1-\theta}} \psi \left(\frac{\varphi}{1+\tau_x}\right)^{\frac{\theta}{1-\theta}} N_o. \tag{15b}$$

A.1.3 Solving for prices and outputs as functions of labor

Agriculture. Using (12d), (14d) with equality, and (14f), we have in symmetric equilibrium:

$$\theta_n p_a A_a \psi^{\theta_n} K_a^{\theta_k} L^{\theta_l} N_a^{\theta_n - 1} Z_a^{\theta_z} = w_o = (1-\theta) A_o^{\frac{1}{1-\theta}} \psi \left(\frac{\varphi}{1+\tau_x}\right)^{\frac{\theta}{1-\theta}}. \tag{16a}$$

Using that in symmetric equilibrium $Z_a = Z_{ja}$ and $p_{zj} = 1$ and dividing (12e) by (16a), we obtain the intermediate goods in agriculture as a function of N_a:

$$Z_a = A_o^{\frac{1}{1-\theta}} \psi \frac{\theta_z(1-\theta)}{\theta_n(1+\tau_z)} \left(\frac{\varphi}{1+\tau_x}\right)^{\frac{\theta}{1-\theta}} N_a. \tag{16b}$$

Substituting this into (12g) gives the capital stock in agriculture as a function of N_a:

$$K_a = A_o^{\frac{1}{1-\theta}} \psi \frac{\theta_k(1-\theta)}{\theta_n \theta} \left(\frac{\varphi}{1+\tau_x}\right)^{\frac{1}{1-\theta}} N_a. \tag{16c}$$

Substituting the expressions for K_a and Z_a back into (1) and (12h), we obtain Y_a and p_a

as functions of N_a:

$$\text{(16d)}\qquad Y_a = \frac{A_o^{\frac{\theta_k+\theta_z}{1-\theta}}\psi^{\theta_n+\theta_k+\theta_z}A_a\theta_k^{\theta_k}\theta_z^{\theta_z}(1-\theta)^{\theta_k+\theta_z}}{\theta_n^{\theta_k+\theta_z}\theta^{\theta_k}(1+\tau_z)^{\theta_z}}\left(\frac{\varphi}{1+\tau_x}\right)^{\frac{\theta_k+\theta\theta_z}{1-\theta}} N_a^{1-\theta_l}L^{\theta_l},$$

$$\text{(16e)}\qquad p_a = \frac{A_o^{\frac{1-\theta_k-\theta_z}{1-\theta}}\psi^{\theta_l}(1-\theta)^{1-\theta_k-\theta_z}\theta^{\theta_k}(1+\tau_z)^{\theta_z}}{A_a\theta_k^{\theta_k}\theta_n^{1-\theta_k-\theta_z}\theta_z^{\theta_z}}\left(\frac{\varphi}{1+\tau_x}\right)^{\frac{\theta(1-\theta_z)-\theta_k}{1-\theta}}\left(\frac{N_a}{L}\right)^{\theta_l}.$$

Intermediate good sectors. (15) imply that

$$Z_a + Z_m + Z_x = \psi\left(\frac{\varphi}{1+\tau_x}\right)^{\frac{\theta}{1-\theta}}\left[A_i^{\frac{1}{1-\theta}}N_i + A_o^{\frac{1}{1-\theta}}N_o\right].$$

Using (16b), this becomes:

$$\text{(17)}\qquad Z_m + Z_x = \psi\left(\frac{\varphi}{1+\tau_x}\right)^{\frac{\theta}{1-\theta}}\left[A_i^{\frac{1}{1-\theta}}N_i + A_o^{\frac{1}{1-\theta}}N_o - \frac{\theta_z(1-\theta)}{\theta_n(1+\tau_z)}A_o^{\frac{1}{1-\theta}}N_a\right].$$

In symmetric equilibrium, A_xZ_x equals the depreciation rate times the capital stocks:

$$Z_m = \psi\left(\frac{\varphi}{1+\tau_x}\right)^{\frac{\theta}{1-\theta}}\left[A_i^{\frac{1}{1-\theta}}N_i + A_o^{\frac{1}{1-\theta}}N_o - \frac{\theta_z(1-\theta)}{\theta_n(1+\tau_z)}A_o^{\frac{1}{1-\theta}}N_a\right] - \frac{\delta(K_a+K_i+K_o)}{A_x}.$$

Using (14e), (14f), and (16c), this gives:

$$\text{(18)}\quad Z_m = \psi\left(\frac{\varphi}{1+\tau_x}\right)^{\frac{1}{1-\theta}}\left[\frac{[1-\beta(1-\delta)](1+\tau_x)-\beta\delta\theta}{A_x\beta\theta}\left[A_i^{\frac{1}{1-\theta}}N_i + A_o^{\frac{1}{1-\theta}}N_o\right]\right.$$
$$\left. - \frac{\theta_z[1-\beta(1-\delta)](1+\tau_x)+\beta\delta\theta_k(1+\tau_z)}{A_x\beta\theta\theta_n(1+\tau_z)}(1-\theta)A_o^{\frac{1}{1-\theta}}N_a\right].$$

The static first–order conditions, (9), of the consumer problem imply:

$$(1-\alpha)(1+\tau_a)p_a(Y_a-\underline{c}) = \alpha Y_m.$$

Substituting (16d) and (16e) into this equation, using that $Y_m = Z_m$, and solving for Z_m, we find:

(19)

$$
\begin{aligned}
&Z_m \\
&= \frac{(1-\alpha)(1+\tau_a)A_o{}^{\frac{1-\theta_k-\theta_z}{1-\theta}}\psi^{\theta_l}(1-\theta)^{1-\theta_k-\theta_z}\theta^{\theta_k}(1+\tau_z)^{\theta_z}}{\alpha A_a \theta_k{}^{\theta_k}\theta_n{}^{1-\theta_k-\theta_z}\theta_z{}^{\theta_z}}\left(\frac{\varphi}{1+\tau_x}\right)^{\frac{\theta(1-\theta_z)-\theta_k}{1-\theta}}\left(\frac{N_a}{L}\right)^{\theta_l} \\
&\times\left[\frac{A_o{}^{\frac{\theta_k+\theta_z}{1-\theta}}\psi^{\theta_n+\theta_k+\theta_z}A_a\theta_k{}^{\theta_k}\theta_z{}^{\theta_z}(1-\theta)^{\theta_k+\theta_z}}{\theta_n{}^{\theta_k+\theta_z}\theta^{\theta_k}(1+\tau_z)^{\theta_z}}\left(\frac{\varphi}{1+\tau_x}\right)^{\frac{\theta_k+\theta\theta_z}{1-\theta}}N_a{}^{1-\theta_l}L^{\theta_l}-\underline{c}\right].
\end{aligned}
$$

Equating (18) with (19), we obtain the market–clearing condition as a function of N_a, N_i, and N_o:

$$
\begin{aligned}
&\frac{(1-\alpha)(1+\tau_a)A_o{}^{\frac{1-\theta_k-\theta_z}{1-\theta}}\psi^{\theta_l}(1-\theta)^{1-\theta_k-\theta_z}\theta^{\theta_k}(1+\tau_z)^{\theta_z}}{\alpha A_a \theta_k{}^{\theta_k}\theta_n{}^{1-\theta_k-\theta_z}\theta_z{}^{\theta_z}}\left(\frac{\varphi}{1+\tau_x}\right)^{\frac{\theta(1-\theta_z)-\theta_k}{1-\theta}}\left(\frac{N_a}{L}\right)^{\theta_l} \\
&\quad\times\left[\frac{A_o{}^{\frac{\theta_k+\theta_z}{1-\theta}}\psi^{\theta_n+\theta_k+\theta_z}A_a\theta_k{}^{\theta_k}\theta_z{}^{\theta_z}(1-\theta)^{\theta_k+\theta_z}}{\theta_n{}^{\theta_k+\theta_z}\theta^{\theta_k}(1+\tau_z)^{\theta_z}}\left(\frac{\varphi}{1+\tau_x}\right)^{\frac{\theta_k+\theta\theta_z}{1-\theta}}N_a{}^{1-\theta_l}L^{\theta_l}-\underline{c}\right] \\
&\quad+\frac{\theta_z[1-\beta(1-\delta)](1+\tau_x)+\beta\delta\theta_k(1+\tau_z)}{A_x\beta\theta\theta_n(1+\tau_z)}\left(\frac{\varphi}{1+\tau_x}\right)^{\frac{1}{1-\theta}}(1-\theta)A_o{}^{\frac{1}{1-\theta}}\psi N_a \\
&\quad=\frac{[1-\beta(1-\delta)](1+\tau_x)-\beta\delta\theta}{A_x\beta\theta}\left(\frac{\varphi}{1+\tau_x}\right)^{\frac{1}{1-\theta}}\psi\left[A_i{}^{\frac{1}{1-\theta}}N_i+A_o{}^{\frac{1}{1-\theta}}N_o\right].
\end{aligned}
\tag{20}
$$

Since $N_a+N_i+N_o=1$, this is one equation is two unknowns. If one of (N_a, N_i, N_o) is zero (which it will be in symmetric equilibrium), then this is one equation in just one unknown.

A.2 Proof of Proposition 1

When there are no distortions, all households are indifferent between working in agriculture and in final manufacturing. To be able to continue using our notation, we will nonetheless call the households in the intermediate good sectors the insiders, so the TFP in an intermediate good sector is A_i and $N_o = 0$. We then need to find the $N_a \in (0,1)$ that solves (20).

For (20) to be well defined, it needs to be larger than zero when all labor is in agriculture. Imposing $A_o = \overline{A}$ this gives a necessary condition for existence of equilibrium without barriers:

$$\text{(21a)} \qquad \frac{\overline{A}^{\frac{\theta_k+\theta_z}{1-\theta}} A_a {\theta_k}^{\theta_k} {\theta_z}^{\theta_z} (1-\theta)^{\theta_k+\theta_z} \varphi^{\frac{\theta_k+\theta\theta_z}{1-\theta}}}{{\theta_n}^{\theta_k+\theta_z} \theta^{\theta_k}} {N_a}^{1-\theta_l} L^{\theta_l} > \underline{c}.$$

This condition is satisfied if A_a is large enough.

For $N_a = 0$, the left–hand side of (20) is zero and the right–hand side is positive. For $N_a = 1$, the left–hand side is positive and the right–hand side is zero. Using that $N_i = 1 - N_a$, we can also see that the left–hand side is increasing and the right–hand side is decreasing in N_a. Thus, there is a unique $N_a \in (0, 1)$ that solves (20). **QED.**

A.3 Proof of Proposition 2

A.3.1 Characterizing A_i in steady state equilibrium

We start by showing that the insider technology must be operated in equilibrium. To see this suppose to the contrary that only the agricultural technology and the outsider technology were operated. The outsiders and insiders would then earn the same marginal value product in agriculture, which would equal the outsider marginal value product in the intermediate good sector. Moreover, p_a would be given to the insider group. But then the insider group could choose $A_i > A_o$ and achieve a higher marginal value product than the outsiders in the intermediate good sector. The latter equals what both the outsiders and the insiders get in agriculture, so we have a contraction.

Given that the agricultural and the insider technology are operated in equilibrium we are left with two cases. In the first case, the outsiders strictly prefer to work in agriculture. In the second case, the outsiders are indifferent between operating and not operating the outsider technology. Note that in the second case the outsider technology may or may not be operated.

Before we can analyze the two cases, we need to characterize the solution to the group's problem. It is sufficient to consider the effect of choosing $A_i{}'$ on next period's insider wage $w^{i\prime}$. The reason is that the insiders supply labor inelastically and the group's choice do not affect any price except for $w^{i\prime}$. Maximizing insider utility is then equivalent to maximizing insider wage income and the group affects insider wage income through its effect on $w^{i\prime}$.

$\boldsymbol{N_o = 0}$ **and** $\boldsymbol{N_i = \Lambda}$. The semi reduced–form of the insider wage will be a function of A_i, which the group chooses, and of the aggregate state S, which the group does not affect. Since $K_i, N_i > 0$, the first–order conditions (14a) and (14b) hold with equality and the insider wage satisfies:

$$w_i(\boldsymbol{\mathcal{S}}, A_i) = p_z(\boldsymbol{\mathcal{S}}, A_i)^{\frac{1}{1-\theta}} A_i{}^{\frac{1}{1-\theta}} \psi \left(\frac{\theta}{r_k(\boldsymbol{\mathcal{S}})}\right)^{\frac{\theta}{1-\theta}}. \tag{22a}$$

In order to obtain an explicit expression for $p_z(\boldsymbol{\mathcal{S}}, A_i)$ we equate the supply of Z_i, equation (2), with its demand, as implied by equations (12e) and (13):

$$A_i \psi^{1-\theta} K_i(\boldsymbol{\mathcal{S}}, A_i)^{\theta} \Lambda^{1-\theta} = \frac{F(\boldsymbol{\mathcal{S}})}{p_z(\boldsymbol{\mathcal{S}}, A_i)^{\sigma}},$$

where

$$F(\boldsymbol{\mathcal{S}}) \equiv Z_m(\boldsymbol{\mathcal{S}}) + [p_x(\boldsymbol{\mathcal{S}}) A_x]^{\sigma} + \left[\frac{\theta_z p_a(\boldsymbol{\mathcal{S}}) Y_a(\boldsymbol{\mathcal{S}})}{1+\tau_z}\right]^{\sigma} Z_a(\boldsymbol{\mathcal{S}})^{1-\sigma}.$$

Rearranging this results in:

$$p_z(\boldsymbol{\mathcal{S}}, A_i) = \left[\frac{F(\boldsymbol{\mathcal{S}})}{A_i \psi^{1-\theta} K_i(\boldsymbol{\mathcal{S}}, A_i)^{\theta} \Lambda^{1-\theta}}\right]^{\frac{1}{\sigma}}. \tag{22b}$$

Substituting this expression into (14a) and solving for K_{ij}/Λ, we find:

$$\frac{K_i(\boldsymbol{\mathcal{S}}, A_i)}{\Lambda} = \left[\frac{\theta^{\sigma} F(\boldsymbol{\mathcal{S}})}{\Lambda r_k(\boldsymbol{\mathcal{S}})^{\sigma} A_i{}^{1-\sigma} \psi^{(1-\theta)(1-\sigma)}}\right]^{\frac{1}{\theta+\sigma(1-\theta)}}.$$

Combining this expression with (22b) gives us the semi–reduced form for the relative price:

$$p_z(\boldsymbol{\mathcal{S}}, A_i) = \left[\frac{r_k(\boldsymbol{\mathcal{S}})^\theta F(\boldsymbol{\mathcal{S}})^{1-\theta}}{\theta^\theta \Lambda^{1-\theta} A_i \psi^{1-\theta}}\right]^{\frac{1}{\theta+\sigma(1-\theta)}}.$$

The semi–reduced form for the insider wage results after substituting this equation into (22a):

$$w_i(\boldsymbol{\mathcal{S}}, A_i) = (1-\theta)\left[\frac{F(\boldsymbol{\mathcal{S}}) r_k(\boldsymbol{\mathcal{S}})^{\theta(1-\sigma)}}{\Lambda \theta^{\theta(1-\sigma)}}\right]^{\frac{1}{\theta+\sigma(1-\theta)}} \left(A_i \psi^{1-\theta}\right)^{\frac{\sigma-1}{\theta+\sigma(1-\theta)}}.$$

Given that $\sigma < 1$ the group can increase this expression by decreasing A_i. Thus the first case is inconsistent with a solution to the group's problem.

$\boldsymbol{N_o \geq 0}$ **and** $\boldsymbol{N_i = \Lambda}$. In this second case, (12d) and (14d) hold with equality, implying that

$$p_z(\boldsymbol{\mathcal{S}}, A_i) = \frac{\theta_n p_a(\boldsymbol{\mathcal{S}}) A_a \psi^{\theta_n} K_a(\boldsymbol{\mathcal{S}})^{\theta_k} (1-\Lambda)^{\theta_n - 1} Z_a(\boldsymbol{\mathcal{S}})^{\theta_z} L^{\theta_l}}{(1-\theta) A_o \psi^{1-\theta} [K_o(\boldsymbol{\mathcal{S}})/N_o(\boldsymbol{\mathcal{S}})]^\theta}.$$

Using (14f), this becomes:

$$p_z(\boldsymbol{\mathcal{S}}, A_i) = \frac{\theta_n p_a(\boldsymbol{\mathcal{S}}) Y_a(\boldsymbol{\mathcal{S}})}{(1-\theta) A_o^{\frac{1}{1-\theta}} \psi N_a(\boldsymbol{\mathcal{S}})} \left(\frac{1+\tau_x}{\varphi}\right)^{\frac{\theta}{1-\theta}}.$$

Consequently S uniquely determines p_z. Increasing A_i then increases the marginal value product of insider labor. The group will therefore choose the largest A_i for which this second case applies. At this A_i the outsider technology is just not operated.

We now show that there is a unique A_i at which the outsider technology is just not operated and all markets clear.

A.3.2 Market clearing

The market–clearing condition (20) now takes the form:

$$\frac{(1-\alpha)(1+\tau_a)A_o^{\frac{1-\theta_k-\theta_z}{1-\theta}}\psi^{\theta_l}(1-\theta)^{1-\theta_k-\theta_z}\theta^{\theta_k}(1+\tau_z)^{\theta_z}}{\alpha A_a \psi^{\theta_n}\theta_k{}^{\theta_k}\theta_n{}^{1-\theta_k-\theta_z}\theta_z{}^{\theta_z}}\left(\frac{\varphi}{1+\tau_x}\right)^{\frac{\theta(1-\theta_z)-\theta_k}{1-\theta}}\frac{(1-\Lambda)^{\theta_l}}{L^{\theta_l}}$$
$$\times\left[\frac{A_o^{\frac{\theta_k+\theta_z}{1-\theta}}\psi^{\theta_n+\theta_k+\theta_z}A_a\theta_k{}^{\theta_k}\theta_z{}^{\theta_z}(1-\theta)^{\theta_k+\theta_z}}{\theta_n{}^{\theta_k+\theta_z}\theta^{\theta_k}(1+\tau_z)^{\theta_z}}\left(\frac{\varphi}{1+\tau_x}\right)^{\frac{\theta_k+\theta\theta_z}{1-\theta}}(1-\Lambda)^{1-\theta_l}L^{\theta_l}-\underline{c}\right]$$
$$+\frac{\theta_z[1-\beta(1-\delta)](1+\tau_x)+\beta\delta\theta_k(1+\tau_z)}{A_x\beta\theta\theta_n(1+\tau_z)}\left(\frac{\varphi}{1+\tau_x}\right)^{\frac{1}{1-\theta}}(1-\theta)\psi A_o^{\frac{1}{1-\theta}}(1-\Lambda)$$

(23a)

$$=\frac{[1-\beta(1-\delta)](1+\tau_x)-\beta\delta\theta}{A_x\beta\theta}\left(\frac{\varphi}{1+\tau_x}\right)^{\frac{1}{1-\theta}}\psi A_i{}^{\frac{1}{1-\theta}}\Lambda.$$

We have to show that there is a unique $A_i = [A_o, \overline{A}]$ that satisfies this equation and clears the market.

We first require that agricultural production does not fall short of subsistence consumption. In the distorted economy this takes the form:

(23b) $$\frac{A_o^{\frac{\theta_k+\theta_z}{1-\theta}}\psi^{\theta_n+\theta_k+\theta_z}A_a\theta_k{}^{\theta_k}\theta_z{}^{\theta_z}(1-\theta)^{\theta_k+\theta_z}}{\theta_n{}^{\theta_k+\theta_z}\theta^{\theta_k}(1+\tau_z)^{\theta_z}}\left(\frac{\varphi}{1+\tau_x}\right)^{\frac{\theta_k+\theta\theta_z}{1-\theta}}(1-\Lambda)^{1-\theta_l}L^{\theta_l}>\underline{c},$$

which is satisfied if A_a is sufficiently large. We also require that for $A_i = A_o$ the right–hand side is smaller than the left–hand side and for $A_i = \overline{A}$ the right–hand side larger the left–hand side. This leads to the following two conditions:

$$
\begin{aligned}
&{A_o}^{\frac{1}{1-\theta}}\psi\,\Lambda < \frac{A_x\beta\theta}{[1-\beta(1-\delta)](1+\tau_x)-\beta\delta\theta}\times \\
&\left\{\frac{(1-\alpha)(1+\tau_a){A_o}^{\frac{1-\theta_k-\theta_z}{1-\theta}}\psi^{\theta_l}(1-\theta)^{1-\theta_k-\theta_z}\theta^{\,\theta_k}(1+\tau_z)^{\theta_z}}{\alpha A_a{\theta_k}^{\theta_k}{\theta_n}^{1-\theta_k-\theta_z}{\theta_z}^{\theta_z}}\left(\frac{1+\tau_x}{\varphi}\right)^{\frac{1-\theta(1-\theta_z)+\theta_k}{1-\theta}}\frac{(1-\Lambda)^{\theta_l}}{L^{\,\theta_l}}\right. \\
&\quad\times\left[\frac{{A_o}^{\frac{\theta_k+\theta_z}{1-\theta}}\psi^{\theta_n+\theta_k+\theta_z}A_a{\theta_k}^{\theta_k}{\theta_z}^{\theta_z}(1-\theta)^{\theta_k+\theta_z}}{{\theta_n}^{\theta_k+\theta_z}\theta^{\,\theta_k}(1+\tau_z)^{\theta_z}}\left(\frac{\varphi}{1+\tau_x}\right)^{\frac{\theta_k+\theta\theta_z}{1-\theta}}(1-\Lambda)^{1-\theta_l}L^{\,\theta_l}-\underline{c}\right] \\
&\qquad\left.+\frac{\theta_z[1-\beta(1-\delta)](1+\tau_x)+\beta\delta\theta_k(1+\tau_z)}{A_x\beta\theta\theta_n(1+\tau_z)}(1-\theta){A_o}^{\frac{1}{1-\theta}}\psi(1-\Lambda)\right\}
\end{aligned}
$$

(23c)

$$<\overline{A}^{\,\frac{1}{1-\theta}}\psi\,\Lambda.$$

Condition (23b) ensures that the expression between the inequality signs is positive, so if Λ is sufficiently small and $\overline{A}$ is sufficiently large, then both inequalities will be satisfied.

We can now prove existence and uniqueness. The left–hand side of (23a) does not depend on A_i and (23b) ensures that it is positive. The right–hand side of (23a) is monotonically increasing in A_i. Since (23c) ensures that for $A_i = A_o$ the right–hand side is smaller than the left–hand side and for $A_i = \overline{A}$ the right–hand side larger the left–hand side, there is a unique intersection at the unique market–clearing $A_i \in [A_o, \overline{A}]$.

The comparative static effects then follow trivially from (23a). **QED.**

A.3.3 Existence and uniqueness

The environment is stationary. It satisfies the standard assumption that guarantee the existence of unique value functions and a unique steady state equilibrium; see Chapter 4 of Stokey and Lucas (1989). **QED.**

Appendix B Robustness Analysis Regarding the Share of Intermediate Goods in Agriculture

Here, we report the findings of our model when we reduce the share of intermediate goods in agriculture from $\theta_z = 0.47$, which we used in the text, to $\theta_z = 0.3$ or $\theta_z = 0.1$. This serves to show that our findings are not sensitive to the particular choice of this parameter. In particular, Table 6 shows that we still hit the targets well. Perhaps more surprisingly, Tables 7 and 8 show that the decomposition of the aggregate differences does not change much compared to Table 3 in the text.

Table 6: Targets for joint calibration for $\theta_z = 0.3$ and $\theta_z = 0.1$

	$\frac{Y^{US}}{Y^{PC}}$	$\frac{Y_a}{Y_c}^{US}$	$\frac{Y_a}{Y_c}^{PC}$	$\frac{Y_x}{Y}^{US}$	$\frac{Y_x}{Y}^{PC}$	N_a^{US}	$\frac{p_a}{p_m}^{US}$	$\frac{p_a}{p_m}^{PC}$
Data	17.7	0.14	0.42	0.21	0.12	0.03	0.65	2.1
Model with $\theta_z = 0.3$	18.9	0.14	0.37	0.20	0.06	0.04	0.67	2.1
Model with $\theta_z = 0.1$	18.5	0.14	0.37	0.20	0.08	0.06	0.69	2.1

Table 7: Decomposition of the aggregate differences for $\theta_z = 0.3$ (U for undistorted and D for distorted economy)

Distortions	$\frac{Y^U}{Y^D}$	$\frac{A^U}{A^D}$	$\frac{\frac{K}{N}^U}{\frac{K}{N}^D}$
No distortions	1.0	1.0	1.0
Taxes only	1.9	1.1	5.7
Taxes, efficiency units only	3.4	1.6	10.3
Taxes, efficiency units, agr. TFP only	3.8	1.8	10.3
Taxes, efficiency units, agr. TFP, barriers	18.9	4.8	62.4

Table 8: Decomposition of the aggregate differences for $\theta_z = 0.1$ (U for undistorted and D for distorted economy)

Distortions	$\frac{Y^U}{Y^D}$	$\frac{A^U}{A^D}$	$\frac{\frac{K}{N}^U}{\frac{K}{N}^D}$
No distortions	1.0	1.0	1.0
Taxes only	1.9	1.1	5.7
Taxes, efficiency units only	2.9	1.4	9.1
Taxes, efficiency units, agr. TFP only	4.0	1.9	9.1
Taxes, efficiency units, agr. TFP, barriers	18.5	5.2	46.9

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