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A new scramble for land or an unprecedented
opportunity for the rural poor?
Distributional consequences of increasing land rents in
developing countries

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13th January 2014

Abstract

Price induced increases in land rents trigger an increasing incentive for rent-seeking behavior. To analyse distributional and welfare effects of increasing land rents in developing countries, we develop a game theoretic model where a large and heterogeneous group of farmers competes with a small and wealthy elite. The results indicate that only relatively small rent increases benefit the farmers more than the elite. Moreover, political institutions have an ambiguous effect on farmers' rent share, and may even reduce overall welfare, because they induce wasteful expenditure on rent-seeking.

JEL classification: D72, D74, N50, O13

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1 Introduction

In 2007, 75,000 Mexicans demonstrated against price increases of 400% for their main staple food: corn based tortillas. These ‘Tortilla riots’ were the most prominent in a series of similar incidents worldwide. Two years later, China’s intensive farmland acquisition in especially Sub-Saharan Africa focused media attention on the phenomenon of increasing foreign direct investment in farmland occurring in developing and transition countries (Collier and Venables, 2012), known as ‘land grabbing’. These seemingly unrelated events had a common denominator in the upwards trending and increasingly volatile global food prices of the last decade and, more importantly, expected future price increases for agricultural products (e.g. Deininger et al., 2011). These price increases are driven by a combination of the following factors: soaring speculation on futures trading markets; an increasing world population and haltering agricultural productivity; changing diets towards land-intensive foods in emerging economies; and highly subsidised biofuel programs, primarily in the USA and the EU. Subsidies for biofuels, in particular, have stimulated intense discussion about the implications of targets for bioenergy requirements for socio-economic circumstances in developing countries. In the discussion of the socio-economic effects of increasing biofuel production, it is commonly acknowledged that rising food prices will have an adverse effect on the world’s poorest, although, it is less clear if and how land-abundant developing countries can take advantage of higher agricultural prices and increasing demand for farm land to reduce rural poverty and eventually promote economic growth (e.g. Deininger et al., 2011; Robertson and Pinstrup-Andersen, 2010; McCarthy, 2010).

While there is increasing demand for agricultural commodities the supply of agricultural land is fixed (FAOstat), which means that the value of land, or land rents has been increasing.¹, in many parts of the world (Hertel, 2010). The increase in land rents has the potential to catapult the formerly low-value natural resource land into the category of high-value resources like oil, coal, or timber. However, the lessons learned from countries that have experienced windfall gains from high-value natural resources indicate that institutionally weak countries struggle with rent-seeking behaviour and increasing income inequality (e.g. Mehlum et al., 2006; Torvik, 2009). Rent-seeking as a consequence of increasing land rents can occur through two channels: by appropriating the farmland, either for own use or for selling or leasing² the farmland to foreign investors, and/or by increasing taxation of the agricultural sector. The appropriation of agricultural rents is potentially a profitable activity, since, in contrast to other high-value natural resources, property rights over land tend to be weak in developing countries (van der Ploeg, 2011), and the taxation system is traditionally biased against the agricultural sector (e.g. Gawande and Hoekman, 2010). In this rather unpromising setting, it is unclear whether increasing land rents will become a ‘blessing’ to developing countries, contributing to rural poverty alleviation, or a ‘curse’³, like other high-value resources where the rents only benefit a small group of individuals.

As outlined in Figure 1, the extent of rent-seeking behaviour induced by a valuable

¹Land rent is defined in the classical Ricardian sense as the payment to an inelastic input resource, i.e. the remainder of the revenue per hectare after all other input factors have been paid off. As in the Ricardian framework, the land rent declines in tact with declining farmland quality measured by yield per hectare.

²This might also include gains from bribery.

³Curse in this context is understood as the adverse effect of a natural resource on economic development, income distribution, and politically induced conflicts (e.g. Dube and Vargas, 2006).

natural resource determines its effect on income distribution, because a high degree of rent seeking results in the allocation of rents towards groups with a comparative advantage in rent seeking (e.g. Mehlum et al., 2006; Torvik, 2009). The extent of rent-seeking,

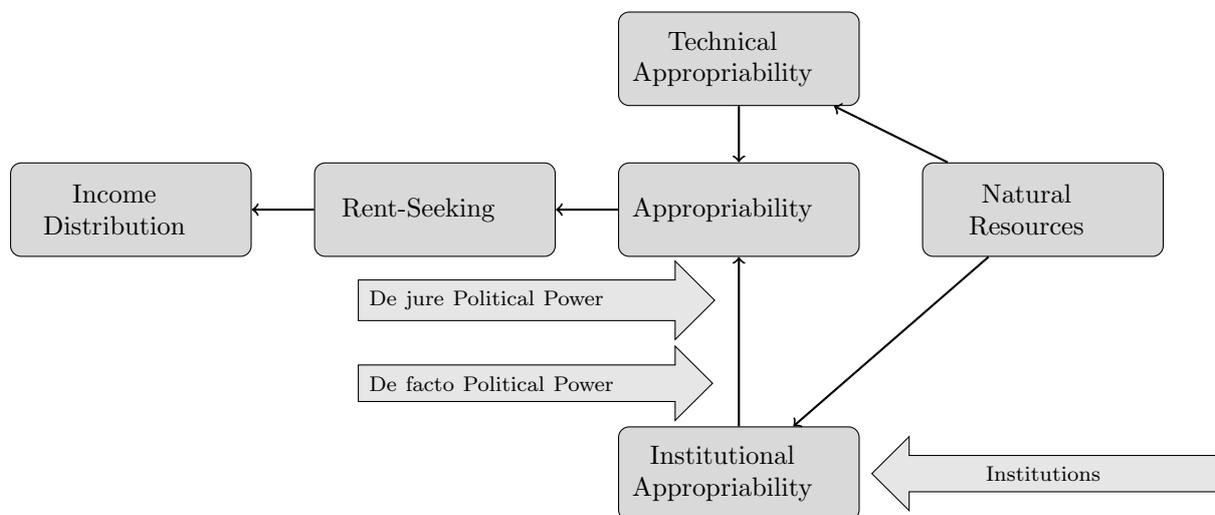


Figure 1: Effect of natural resources on income distribution

in turn, is affected by the *appropriability* of the resource, which indicates the extent to which the resource rents can be appropriated by specific groups or individuals (Boschini et al., 2007). Following Boschini et al. (2007), appropriability divides into a measure of the quality of relevant institutions in the country, referred to as *institutional appropriability*, and a measure of the specific type of the resource, referred to as *technical appropriability*. Figure 2 demonstrates that technical appropriability further splits into: the economic

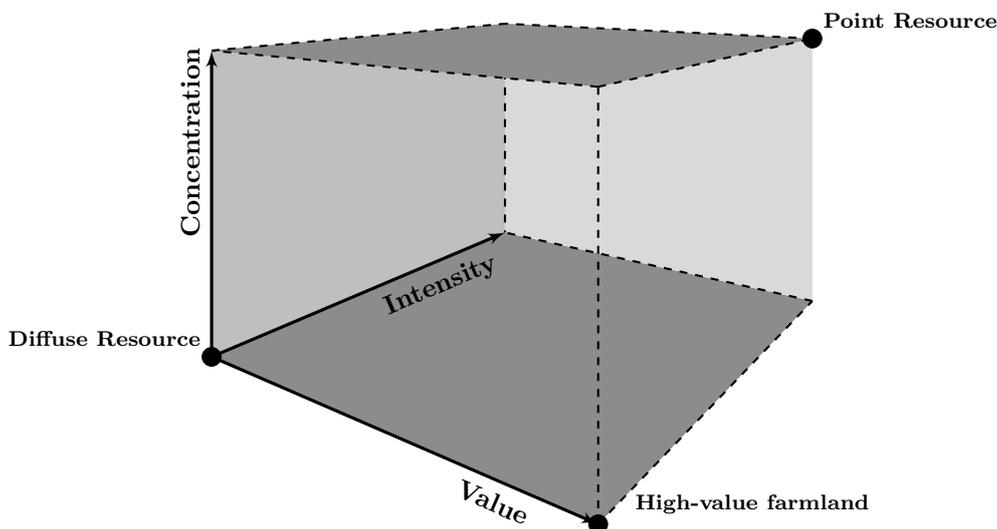


Figure 2: Technical appropriability characteristics of point resources and diffuse resources

value of the natural resource (x-axis), the geographic concentration (y-axis), and the extraction characteristics such as capital and skill intensity (z-axis). The literature has so far divided natural resources into resources with low value, low geographical concentration, and low extraction intensity, called *diffuse resources* (origin), and resources with high value, high geographical concentration, and high extraction intensity, called *point*

resources (upper right corner). However, high-value farmland deviates from this classification as it, in most instances, combines a high value with low geographical concentration and low skill and capital intensity (e.g. Barrett et al., 2010), while compared to ‘classical’ point resources such as oil or precious metals, rents from high value farm land remain easily accessible to small scale farmers, but, since they are geographically dispersed, they are less accessible to other groups.

Hence, since the characteristics of high-value farmland are very different to those of classical point resources, we suggest a more differentiated approach to institutional appropriability than the one proposed by Boschini et al. (2007). More specifically, we introduce a political economy approach inspired by Acemoglu and Robinson (2008), and argue that the degree of institutional appropriability depends on the combination of *de jure* political power and *de facto* political power (see Figure 1). While *de jure* political power is determined by political institutions, the allocation of *de facto* political power results from equilibrium investments and the organizational capacity of opposing groups, i.e. groups possess *de facto* political power as a result of their wealth, their group size, and their ability to solve the collective action problem (Olson, 1971). To model this extended framework of rent-seeking behaviour we use a game-theoretic approach, and build on the work of Tullock (1980), Becker (1983), and others, but particularly on Hirshleifer (1991). Like Hirshleifer, we model two competing groups, small scale farmers and an elite, operating in a Cournot-Nash framework. In contrast to Hirshleifer, our model assumes different group characteristics that affect the organizational capacity of small scale farmers and the elite. Furthermore, we model the investment decision in a dynamic, two-period framework where we allow for different initial endowments of capital and different time preferences for each group. An external shock, in our case an externally induced increase in land value, forces the two groups to readjust their investment decisions into *de facto* political power. Based on this approach, we assume that the elite initially holds *de facto* political power due to their initial wealth and their small and homogeneous group structure, while small scale farmers can eventually turn a group size advantage into *de facto* political power if they are able to solve their collective action problem. We argue that increasing land rents will induce the farmers to invest in *de facto* political power, but that external factors will determine the return on this investment, and consequently the share of the rents the farmers can keep.

The paper is structured as follows: Section 2 introduces the theoretical setup, section 3 analyses the situation where farmers’ budget constraint is not binding, and section 4 analyses the situation where the farmers’ budget constraint is binding. Section 5 analyses the effect of price increases on the relative consumption of the two groups, section 6 summarizes the results and relates them to some historical examples of increasing rents in agriculture, and finally section 7 concludes.

2 Investment in political influence

We consider a simple endowment economy where income is solely generated by natural resources, and hence, we abstract from any production in the economy. The two groups, farmers, denoted by f , and the elite, denoted by e , maximize utility over two periods, subject to a political power production technology, which converts economic resources spent on political organization into *de facto* political power. In this simple two-period setup, economic resources spent on political organization can be seen as an investment

made in period t , which pays off in period $t + 1$ in the form of de facto political power which translates into land rent shares. In accordance with Hirshleifer (1991) and others, we assume that both groups operate under Cournot competition, i.e. when choosing the optimal level of investment in de facto political power, each group takes the other group's level of investment into account.

The two groups differ in their characteristics and the type of natural resources they are initially endowed with. Specifically, the group of farmers is larger and more diverse than the elite. Furthermore, farmers derive income from agriculture, which is of very low value in the first period before the price increase. The elite derives income from their initial wealth⁴, giving them an initial advantage in generating de facto political power. When agricultural prices increase, land rents increase in tact, giving the elite increasing incentives to use their political superiority to appropriate the land rents. However, since land rents initially accrue directly to the farmers, appropriation of land rents by the elite will be experienced as a loss of (potential) income by the farmers. The only way the farmers can prevent appropriation is by investing in de facto political power.

We specify de facto political power by a contest success function, along the lines of Hirshleifer (1991)⁵. The de facto political power of each group is given by a combination of expenditure on political organization and the group's organizational capacity. The farmers' de facto political power in period $t + 1$, $p_{f,t+1}$, is given by

$$p_{f,t+1} = \frac{mn^{1-\alpha}F_{f,t}}{mn^{1-\alpha}F_{f,t} + m^{-1}RkF_{e,t}} \quad (1)$$

where $F_{i,t} \geq 0$, $i \in \{f, e\}$ is the amount of economic resources spent by group i on political organization in period t . $m \in \mathbb{R}^+$ represents the political institutions that regulate de jure political power, with larger values indicating better functioning political institutions. $mn^{1-\alpha}$ is the farmers' organisational capacity which, in accordance with the collective action literature (e.g. Olson, 1971; Becker, 1983; Alesina et al., 2003), depends on the group size, $n \in \mathbb{N}^+$, and group heterogeneity, $\alpha \in \mathbb{R}^6$. A larger degree of heterogeneity, i.e. $\alpha > 1$, implies more costly cooperation. Moreover, the effect of group size on organizational efficiency depends on the degree of heterogeneity. If heterogeneity is high, then group size has a negative effect on organizational efficiency, and vice versa⁷. $m^{-1}Rk$ is the organizational capacity of the elite, where $R \in \mathbb{R}^+$, is the income generated from the wealth possessed by the elite; and $k \in (0, 1)$, is the geographic concentration of valuable land. If valuable land is highly concentrated, the elite will have a comparative advantage over the farmers in appropriating land rents, because it will be less costly for them to appropriate rents from a more geographically concentrated area (see e.g. Acemoglu et al., 2004; Acemoglu and Robinson, 2008; Anderson et al., 2012; Acemoglu et al., 2013). Furthermore we assume that well-functioning political institutions (high m), negatively affect the elite's ability to appropriate land rents from the farmers. If m is low, economic superiority translates into political superiority to a larger extent, than if m is high, in which case group size is a stronger determinant of de facto political power. In this sense, m is an indicator of the relative importance of economic superiority to group size, and hence, could for example represent the degree of democracy.

⁴This could for example be resource rents generated by point source resources possessed by the elite.

⁵See also Tullock (1980); Becker (1983); Paul and Wilhite (1990); Caselli (2006).

⁶Empirical support of these relationships is for example provided in Grootaert (1999); O'Rourke (2007); Bates and Block (2009).

⁷This relationship is deduced from the effect of group size and heterogeneity proposed by the collective action literature mentioned above.

Similarly, the elite's de facto political power in period $t + 1$ is

$$p_{e,t+1} = \frac{m^{-1}RkF_{e,t}}{mn^{1-\alpha}F_{f,t} + m^{-1}RkF_{e,t}} \quad (2)$$

where $0 \leq p_{i,t+1} \leq 1$ and $\sum p_{i,t+1} = 1$.

Under this postulate, the farmers' utility maximization problem is defined as follows:

$$\max_{F_{f,t}} \quad \beta C_{f,t} + (1 - \beta)C_{f,t+1} \quad (3)$$

$$\text{s.t.} \quad C_{f,t} = A - F_{f,t} \quad (4)$$

$$C_{f,t+1} = p_{f,t+1}\delta A \quad (5)$$

$$p_{f,t+1} = \frac{mn^{1-\alpha}F_{f,t}}{mn^{1-\alpha}F_{f,t} + m^{-1}RkF_{e,t}} \quad (6)$$

$$C_{f,t}, C_{f,t+1}, F_{f,t} \geq 0 \quad (7)$$

where $0 < \beta < 1$ is a time preference parameter, $m, n^{1-\alpha}, R, k$ are non-negative constants, A is the initial land rent before the price increase, and $\delta = \frac{A_{t+1}}{A_t}$ represents the relative change in land rents between two periods. Farmers maximize utility from consumption in the two periods, $C_{f,t}$ and $C_{f,t+1}$, by choosing political organization expenditure in period t , $F_{f,t}$. The choice of $F_{f,t}$ affects the level of de facto political power and hence, all else equal, the share of rents that the farmers can keep in period $t + 1$. Consumption over the two periods is weighted by the time preference parameter β .

Equation (4) states that period t consumption is given by income generated from agricultural land minus expenditure on political organization. Equation (5) states that consumption in period $t + 1$ is given by the share of agricultural rents that farmers are able to keep after the price increase. Expenditure on political organization is converted into effective de facto political power via the organizational technology, equation (6), as discussed above, and, lastly, consumption and expenditure must be positive (7). Without loss of information we can reduce this problem to a constrained optimization problem with two non-negativity conditions (see Appendix A.1). Moreover, for $F_{f,t} \geq 0$ the problem is convex, and therefore, points satisfying the Karush-Kuhn-Tucker conditions are unique solutions to the optimization problem.

The elite's utility maximization problem takes a similar form

$$\max_{F_{e,t}} \quad \gamma C_{e,t} + (1 - \gamma)C_{e,t+1} \quad (8)$$

$$\text{s.t.} \quad C_{e,t} = R - F_{e,t} \quad (9)$$

$$C_{e,t+1} = R + p_{e,t+1}\delta A \quad (10)$$

$$p_{e,t+1} = \frac{m^{-1}RkF_{e,t}}{mn^{1-\alpha}F_{f,t} + m^{-1}RkF_{e,t}} \quad (11)$$

$$C_{e,t}, C_{e,t+1}, F_{e,t} \geq 0 \quad (12)$$

The elite maximizes consumption in the two periods, with $0 < \gamma < 1$ being their time preference parameter. Consumption in period t equals income generated from initial wealth minus expenditure on political organization, (9), and consumption in period $t + 1$ is given by the income generated by initial wealth, as well as any land rents appropriated from the farmers (10). De facto political power is given by the organization technology, (11) and, lastly, consumption and organization expenditure must be non-negative (12).

As with the farmers utility maximization we can reduce this problem to one with only two non-negativity conditions, $F_{e,t} \geq 0$ and $R - F_{e,t} > 0$. We assume that R is very large (and specifically $A \ll R$), hence $R - F_{e,t}$ is strictly positive, which means that the elite's optimization problem is unconstrained (see Appendix A.1).

3 Interior solution

Solving the farmers' maximization problem (3)-(7), in the case of $0 < F_{f,t} < A$, gives the farmers' reaction function

$$F_{f,t} = \left(\frac{1 - \beta}{\beta} \delta A \psi F_{e,t} \right)^{\frac{1}{2}} - \psi F_{e,t}. \quad (13)$$

where $\psi \equiv \frac{m^{-1}Rk}{mn^{1-\alpha}}$ is defined as the elite's organizational capacity relative to the farmers' organizational capacity. ψ increases in α , k and R , decreases in m and n , and is strictly convex in m , n , and α . $F_{f,t}$ depends positively on δ , and hence farmers increase spending on political organization when the value of land increases. Moreover, farmers' organizational spending is concave in $\psi F_{e,t}$, i.e. the *effective investment* of the elite affects the choice of the farmers in two opposing ways: (1) positively; because when the elite's effective investment increases, farmers have to increase spending in order to keep the same rent share, and (2) negatively; because increasing effective investment by the elite makes de facto political power more costly for the farmers. Hence, for low values of effective investment by the elite, the benefit for the farmers of increasing organizational effort (in terms of rent share kept) is greater than the cost (in terms of consumption given up in period t) and vice versa.

Similarly, solving (8) to (12) gives the elite's reaction function

$$F_{e,t} = \left(\frac{1 - \gamma}{\gamma} \delta A \frac{1}{\psi} F_{f,t} \right)^{\frac{1}{2}} - \frac{1}{\psi} F_{f,t} \quad (14)$$

The elite's organizational spending is affected by the farmers' effective investment, $\frac{1}{\psi} F_{f,t}$, in the same way that farmers' spending is affected by the elite, for the same reasons.

Equilibrium spending on organization by the farmers is found by substituting (14) into (13) and for the elite by substituting (13) into (14), and by solving for $F_{f,t}^*$ and $F_{e,t}^*$, respectively

$$F_{f,t}^* = \frac{\gamma}{1 - \gamma} \frac{n^{1-\alpha} Rk \delta A}{\left(\frac{\gamma}{1-\gamma} mn^{1-\alpha} + \frac{\beta}{1-\beta} m^{-1} Rk \right)^2} = \frac{\gamma}{1 - \gamma} \frac{\psi}{\left(\frac{\gamma}{1-\gamma} + \frac{\beta}{1-\beta} \psi \right)^2} \delta A \quad (15)$$

$$F_{e,t}^* = \frac{\beta}{1 - \beta} \frac{n^{1-\alpha} Rk \delta A}{\left(\frac{\gamma}{1-\gamma} mn^{1-\alpha} + \frac{\beta}{1-\beta} m^{-1} Rk \right)^2} = \frac{\beta}{1 - \beta} \frac{\psi}{\left(\frac{\gamma}{1-\gamma} + \frac{\beta}{1-\beta} \psi \right)^2} \delta A. \quad (16)$$

3.1 Equal time preferences

In the following we assume equal time preferences. Comparing (15) and (16) shows that under equal time preferences, organizational effort is exactly equal in equilibrium, i.e. optimal spending by the two groups is symmetric. Thus, following increasing land rents, farmers and the elite will increase their organization effort by the same amount.

Define $\phi \equiv \frac{\beta}{1-\beta} = \frac{\gamma}{1-\gamma}$. Then, from (15) and (16), political spending by the two groups in equilibrium is given by

$$F_{f,t}^* = F_{e,t}^* = F^* = \frac{\psi}{\phi(1+\psi)^2} \delta A \quad (17)$$

Figure 3 demonstrates the effect of δ on equilibrium expenditures (the intersection of two reaction curves). Under this setting, equilibrium spending is positively correlated with

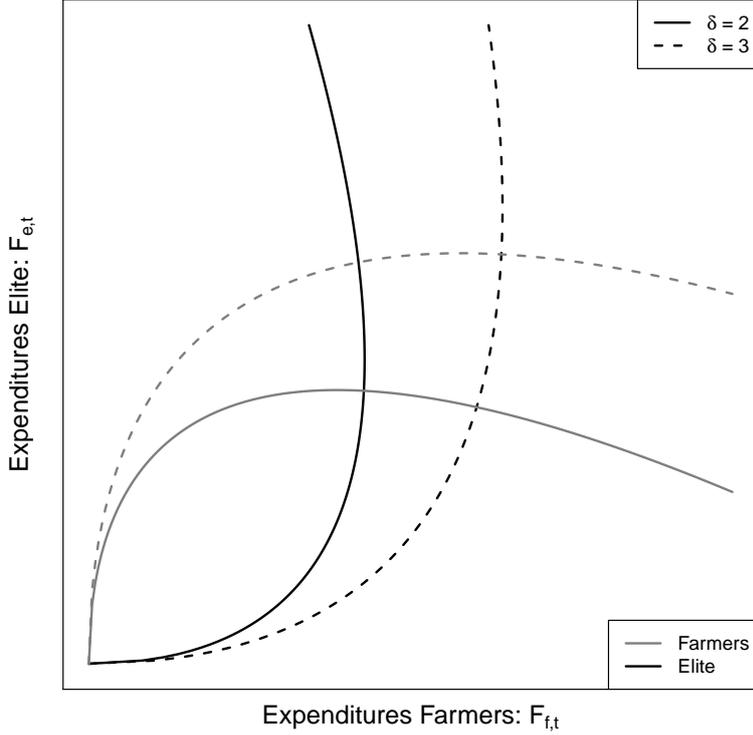


Figure 3: Reaction curves of farmers and the elite.

δA , the initial value of land as well as the increase in land rents.

Equation (17) shows that the amount of resources invested in de facto political power is also determined by the relative organizational capacities of the two groups. The derivative of (17) wrt. ψ is equal to $\delta A \frac{1-\psi^2}{\phi(1+\psi)^2}$, which is equal to zero when $\psi = 1$, positive when $\psi < 1$, and negative when $\psi > 1$. In other words, F^* as a function of ψ follows an inverted u-shape which peaks when both groups have equal organizational capacities and declines in tact with diverging organizational capacities.

The effect of political institutions, m , on equilibrium spending is negative when $\psi < 1$, i.e. when the farmers are the better organized group (see Appendix A.3.1). When farmers are well organized, better political institutions further increase farmers' organizational capacity, while at the same time reducing the organizational capacity of the elite, hence reducing competition for rents. However, in the situation where the elite is better organized, more effective political institutions increase the competition for rents and, hence, equilibrium spending. In this sense, better functioning political institutions have an adverse welfare effect when the elite is the better organized group. More specifically, m increases organizational spending when $m < \left(\frac{Rk}{n^{1-\alpha}}\right)^{\frac{1}{2}}$. This implies that in countries

where political institutions are relatively ineffective, the elite is wealthy, valuable land is geographically concentrated, and farmers are a large and diverse group, a marginal increase in the effectiveness of political institutions will induce higher investments in political organization by both groups, thereby generating a larger welfare loss, because a larger share of the increase in land rents is wasted on political organization.

Since expenditure on political organization is exactly equal in equilibrium, it cancels out in the organization technology equations, (1) and (2), giving de facto political power in period $t + 1$ for the farmers and the elite, respectively

$$p_{f,t+1} = \frac{mn^{1-\alpha}}{mn^{1-\alpha} + m^{-1}Rk} = \frac{1}{1 + \psi} \quad (18)$$

$$p_{e,t+1} = \frac{m^{-1}Rk}{mn^{1-\alpha} + m^{-1}Rk} = \frac{\psi}{1 + \psi}. \quad (19)$$

Hence, in equilibrium, the de facto political power (and thereby the rent share) of each group is simply given by their organizational capacity relative to total organizational capacity. The distribution of land rents is not affected by the size of the increase in rents⁸, because both groups choose equal levels of investment in de facto political power, hence these investments cancel each other out in equilibrium. As we demonstrate in the next two sections, the situation is different when time preferences differ or when the farmers' budget constraint is binding.

The fact that organizational expenditure cancels out in equilibrium has implications for general welfare in terms of total consumption in the economy. An increase in land rents induces the two groups to spend a larger amount of economic resources on political organization, but it does not have any real effect, other than being subtracted from consumption, so it can be regarded as wasted resources (this result is in line with e.g. Becker, 1983; Hirshleifer, 1991).

Proposition 1 *When farmers' budget constraint does not bind, and when farmers and the elite have the same time preferences, greater price increases result in higher organizational spending by the farmers and the elite. The distribution of rents, however, is determined by the relative organizational capacities of the two groups, not by the extent of organizational spending. Moreover, the level of organizational spending, and hence the welfare loss due to rent seeking, increases when the organizational capacity of the two groups is more equal. More effective political institutions may reduce this welfare loss if the farmers are relatively well organized. However, if this is not the case, more effective institutions have adverse effects on overall welfare.*

3.2 Differing time preferences

Differing time preferences between the farmers and the elite is probably a more realistic reflection of the situation in many developing countries, where poor farmers are often relatively impatient (Holden et al., 1998). According to equations (15) and (16), when $\beta \neq \gamma$, expenditure on de facto political power by the two groups is no longer the same. Specifically, $F_{f,t}^*$ decreases in β and $F_{e,t}^*$ decreases in β and γ . This is intuitive, since a higher valuation of consumption in the future makes the investment in period t less costly in terms of forgone consumption in that period, and the payoff from the investment (in

⁸Note that the quality of the political institutions m has a positive impact on farmers' share $p_{f,t+1}$.

the form of larger rent shares) in period $t+1$ more valuable. Moreover, as long as farmers are relatively impatient, the elite will reduce their expenditure, and hence, a situation where the farmers are more impatient, everything else equal, will reduce the welfare loss due to a decrease in investment in political influence.

Substituting (15) into (1) and (16) into (2) gives the following rent shares for the farmers and elite, respectively

$$p_{f,t+1}^* = \frac{\frac{\gamma}{1-\gamma}}{\frac{\gamma}{1-\gamma} + \frac{\beta}{1-\beta}\psi} \quad (20)$$

$$p_{e,t+1}^* = \frac{\frac{\beta}{1-\beta}\psi}{\frac{\beta}{1-\beta}\psi + \frac{\gamma}{1-\gamma}} \quad (21)$$

where $\frac{\partial p_{f,t+1}^*}{\partial \beta} < 0$ and $\frac{\partial p_{e,t+1}^*}{\partial \beta} > 0$, and $p_{f,t+1}^*$ is strictly concave in β . If the farmers weight period t consumption higher, both groups spend less on political influence, but the farmers' reduction in spending is greater than the elite's. As a consequence, the share of the rents going to the farmers, $p_{f,t+1}^*$, will be lower than under equal time preferences.

Proposition 2 *When time preferences differ and farmers are more impatient, this, all else equal, will imply a welfare gain, because both groups decrease their spending on de facto political power. However, the rent share of the farmers decrease with increasing impatience.*

4 Corner solution

If farmers' optimal investment in de facto political power $F_{f,t}$ is larger than A , farmers will spend their entire initial income in period t , i.e. A , on de facto political power. Hence, solving the farmers' maximization problem (3)-(7) for the situation where $F_{f,t} = A$ gives the condition for a corner solution

$$\delta \geq \frac{\beta}{1-\beta} \frac{(A + \psi F_e)^2}{\psi A F_e}. \quad (22)$$

When (22) is satisfied, $F_{f,t} = A$ is the farmers' optimal choice of investment, since it can be shown to satisfy the KKT conditions. The elite takes this into account, and therefore, substituting $F_{f,t} = A$ into the reaction function of the elite, (14), and substituting this back into (22) returns the threshold value of δ for which the corner solution applies.

4.1 Equal time preferences

As in section 3 we first assume that the farmers and the elite have equal time preferences. The threshold value for a corner solution, $\bar{\delta}$, is then defined by

$$\delta \geq \phi \frac{(1 + \psi)^2}{\psi} \equiv \bar{\delta}. \quad (23)$$

Hence, if the price increase is above $\bar{\delta}$, the farmers can no longer respond to price increases by increasing organizational expenditure. Note that $\bar{\delta}$ does not depend on the size of the farmers' initial endowment, A . This is because the elite takes the size of A into account when choosing the level of investment in de facto political power, and hence, while a higher A would increase the endowment and hence the farmers' spending, it would also increase the elite's political spending, which would cancel out the effect.

Substituting $F_{f,t} = A$ and (14) into (1) and (2), we get the farmers' and the elite's de facto political power in period $t + 1$, respectively

$$p_{f,t+1}^c = \left(\frac{\gamma}{1 - \gamma} \frac{mn^{1-\alpha}}{m^{-1}Rk\delta} \right)^{\frac{1}{2}} = \left(\frac{\phi}{\psi\delta} \right)^{\frac{1}{2}} \quad (24)$$

$$p_{e,t+1}^c = 1 - \left(\frac{\gamma}{1 - \gamma} \frac{mn^{1-\alpha}}{m^{-1}Rk\delta} \right)^{\frac{1}{2}} = 1 - \left(\frac{\phi}{\psi\delta} \right)^{\frac{1}{2}} \quad (25)$$

where the superscript c indicates a corner solution. Hence, in contrast to the interior solution case, the distribution of land rents depends on the size of the increase in rents⁹. While farmers are not able to fully react to increases in rents by increasing organizational spending, the elite is unconstrained and the larger the rents, the larger the incentive to appropriate these rents, specifically, as $\delta \rightarrow \infty$, $p_{e,t+1}^c \rightarrow 1$.

It is apparent from equations (24) and (25) that $\frac{\partial p_{f,t+1}^c}{\partial \delta} < 0$ and $\frac{\partial p_{e,t+1}^c}{\partial \delta} > 0$, i.e. in the corner solution an increase in δ will lead to a distribution of land rents biased in favor of the elite. Hence, the size of $\bar{\delta}$ is crucial with respect to the distributional consequences of increasing land rents, since in the situation where $\bar{\delta}$ is very low, farmers will experience losses even in situations with low or moderate price increases. Equation (23) is illustrated in Figure 4 where we have set $\beta = \gamma = 0.5$ for simplicity. The figure illustrates the threshold value, $\bar{\delta}$, as a function of relative organizational capacity. $\bar{\delta}$ decreases as the organizational capacities of both groups approach each other, and reaches its minimum value where $\psi = 1$. As the degree of investment in de facto political power by both groups increases with converging organizational capacities, the farmers' optimal level of investment rises with ψ , which increases the probability that this investment will be larger than their initial endowment.

Proposition 3 *When the price increase exceeds a certain level, the farmers' budget constraint binds, and the distribution of rents depends on the size of the price increase. Specifically, the larger the price increase, the larger the rent share which goes to the elite, no matter how well organized the farmers are. The level of price increase above which farmers' budget constraint binds, decreases as organizational capacities becomes more equal. Hence, in situations where organizational capacities are close to each other, farmers are more likely to find themselves in a corner solution, leaving them with a smaller share of the rents.*

4.2 Differing time preferences

Equation (22) in the case of differing time preferences, $\beta \neq \gamma$ is given by

$$\bar{\delta} = \frac{\beta}{1 - \beta} \left(\frac{\beta}{1 - \beta} \frac{1 - \gamma}{\gamma} \psi + 2 \right) + \frac{\gamma}{1 - \gamma} \frac{1}{\psi} \quad (26)$$

⁹It can be shown that (25) is always positive, by noting that in this case we must have $1 - \left(\frac{mn^{1-\alpha}}{\frac{1-\gamma}{\gamma} m^{-1} Rk\delta} \right)^{\frac{1}{2}} \Leftrightarrow \delta > \frac{\gamma}{1-\gamma} \frac{1}{\psi}$ which can be shown to be true in the corner solution case.

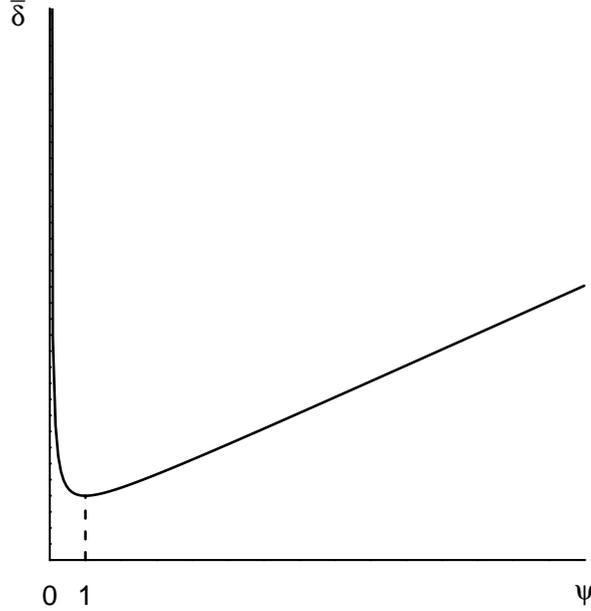


Figure 4: Threshold value $\bar{\delta}$ and relative organizational capacity.

which is strictly convex and increasing in β^{10} and strictly concave and decreasing in γ^{11} . Hence, the more farmers value consumption in period t relative to consumption in period $t + 1$, the larger $\bar{\delta}$. This is intuitive, since the more impatient farmers are, the less they will spend on de facto political power for a given increase in land rents, and hence, the more rents can increase before the farmers' optimal investment exceeds their initial endowment.

According to equations (24) and (25), in the corner solution, only the elite's time preferences matter with respect to the distribution of rents, because farmers' spending is unaffected by their time preferences. As the elite put greater weight on the future (γ small) the farmers receive a smaller share (as $\frac{\partial p_{f,t+1}^c}{\partial \gamma} > 0$). Moreover, as in the case of equal time preferences, the farmers' share decreases in δ . On the other hand, as $\bar{\delta}$ depends positively on β , higher preferences for present consumption imply that a corner solution will set in at a relatively higher level of δ .

Time preferences also have a crucial impact on the influence of ψ on $\bar{\delta}$. More specifically, the influence of ψ on $\bar{\delta}$ depends on the ratio of the elite's and the farmers' time preferences, i.e. $\frac{\partial \bar{\delta}}{\partial \psi} \gtrless 0$ if $\psi \gtrless \frac{\frac{\gamma}{1-\gamma}}{\frac{\beta}{1-\beta}}$. The higher farmers value consumption in period t relative to the elite, $\beta > \gamma$, the lower the values of ψ at which $\bar{\delta}$ reaches its minimum.

Proposition 4 *When time preferences differ, specifically if farmers discount future consumption more than the elite, farmers will experience the same losses in the corner solution situation as under equal time preferences. However, the lower willingness to invest results in higher threshold values before the corner solution steps in. Moreover, the better organized the farmers are relative to the elite, the more damaging the myopic consumption preferences.*

¹⁰ $\frac{\partial \bar{\delta}}{\partial \beta} = \frac{2}{(1-\beta)^2} \left(\frac{\beta}{1-\beta} \frac{1-\gamma}{\gamma} \psi + 1 \right) > 0$.

¹¹ $\frac{\partial \bar{\delta}}{\partial \gamma} = - \left(\frac{\beta}{1-\beta} \right)^2 \frac{\gamma^2 - \gamma + 1}{\gamma^2} \psi + \frac{1}{(1-\gamma)^2} < 0$

5 Effects on consumption

Let the two group's total consumption be given by $\bar{C}_e \equiv C_{e,t} + C_{e,t+1}$ and $\bar{C}_f \equiv C_{f,t} + C_{f,t+1}$, and define relative consumption as the difference between the total consumption of the two groups. Then relative consumption is given by $\bar{C} \equiv \bar{C}_e - \bar{C}_f$, and hence, in the interior solution it is defined as

$$\bar{C} \equiv \bar{C}_e - \bar{C}_f = 2R + A \left[\frac{\left(\frac{\beta}{1-\beta} \psi \right)^2 - \left(\frac{\gamma}{1-\gamma} \right)^2 + \left(\frac{\gamma}{1-\gamma} - \frac{\beta}{1-\beta} \right) \psi}{\left(\frac{\gamma}{1-\gamma} + \frac{\beta}{1-\beta} \psi \right)^2} \cdot \delta - 1 \right]. \quad (27)$$

In the case of equal time preferences, $\phi \equiv \frac{\beta}{1-\beta} = \frac{\gamma}{1-\gamma}$, equation (27) simplifies to

$$\bar{C} \equiv \bar{C}_e - \bar{C}_f = 2R + A \left[\frac{(\psi^2 - 1)\phi^2}{(\phi + \phi\psi)^2} \cdot \delta - 1 \right]. \quad (28)$$

It follows that $\frac{\partial \bar{C}}{\partial \delta} > 0$, if $\psi > 1$, and $\frac{\partial \bar{C}}{\partial \delta} < 0$, if $\psi < 1$. Hence, when the elite's organizational capacity exceeds the farmers', increasing land rents will benefit the elite more than the farmers and vice versa. In the case of unequal time preferences (equation (27)), the above holds, but in addition the influence of the farmers' time preferences on \bar{C} is $\frac{\partial \bar{C}}{\partial \beta} > 0$, only if β is in the realistic range of ≥ 0.5 and $\psi \geq 1$. For $\psi < 1$ the results are ambiguous and depend on the values of β and γ .

Similarly, let \bar{C}^c denote relative consumption in the corner solution

$$\bar{C}^c \equiv \bar{C}_e^c - \bar{C}_f^c = 2R + A \left(\delta + \frac{1}{\psi} - \left(2 \left(\frac{\gamma}{1-\gamma} \right)^{\frac{1}{2}} + \left(\frac{1-\gamma}{\gamma} \right)^{\frac{1}{2}} \right) \left(\frac{\delta}{\psi} \right)^{\frac{1}{2}} \right) \quad (29)$$

It can be shown that

$$\frac{\partial \bar{C}^c}{\partial \delta} = A \left(1 - \left(\frac{2-\gamma}{2(\gamma(1-\gamma))^{\frac{1}{2}}} \right) \left(\frac{1}{\psi\delta} \right)^{\frac{1}{2}} \right) \quad (30)$$

which is negative if $\bar{\delta} \leq \delta < \frac{(2-\gamma)^2}{\gamma(1-\gamma)} \frac{1}{4\psi} \equiv \hat{\delta}^{12}$. Hence, when the increase in rents exceeds $\bar{\delta}$ the distribution of land rents can only be in the farmers' favor for price increases below $\hat{\delta}$.

Moreover, as the elite become more powerful $\hat{\delta}$ decreases, since $\frac{\partial \hat{\delta}}{\partial \psi} < 0$. This is intuitive, as in the corner solution the farmers are bounded by their budget, and hence, cannot react adequately to price increases. Moreover, the elite's time preference, γ , impacts $\hat{\delta}$ twofold: for $\gamma < 0.5$, i.e. in the unrealistic situation where the elite value present consumption lower than future consumption, $\hat{\delta}$ decreases, while a high preference for present consumption, $\gamma \geq 0.5$, increases $\hat{\delta}$. As we assume the elite have moderate preferences for future consumption, in practice, the range of δ where \bar{C}^c is negative will be small.

¹² $\bar{\delta} < \hat{\delta}$ is infeasible if $\psi > \frac{1-\beta}{\beta} \frac{2-3\gamma}{2(1-\gamma)}$

Figure 5 illustrates relative consumption as a function of the size of the price increase, δ , in three different scenarios where neither farmers nor the elite have distinct time preferences ($\beta = \gamma = 0.5$). In the first scenario (dotted line), the farmers' relative organizational capacity is low ($\psi > 1$) and the distribution of rents is in favor of the elite for all levels of price increases. However, when rent increases hit $\bar{\delta}_{\psi > 1}$, the elite's share of the rents increases further, because in the corner solution farmers are unable to increase investment in response to increasing land rents. In the second scenario (solid line), $\psi = 0.5$ which equals the threshold value from whereon $\hat{\delta} \leq \bar{\delta}$ (in our example $\hat{\delta} = 4.5$). Although farmers are the better organized group, which rewards them with a larger share of the rents for low values of δ , they are still limited by their low income the moment δ exceeds $\bar{\delta}$. Hence, even for low values of ψ , the elite will profit from an increase in δ the moment farmers embark in the corner solution. In the third scenario (lower dotted line), farmers are relatively well organized ($\psi < 0.5$), and hence, as long as ($\delta \leq \hat{\delta}$), farmers will gain relative to the elite when rents increase. In the corner solution, though, at $\bar{\delta}_{\psi < 0.5}$, a different dynamic sets in, and when δ exceeds $\hat{\delta}_{\psi < 0.5}$ (in our example $\hat{\delta} = 11.5$), the elite will again benefit at the expense of the farmers.

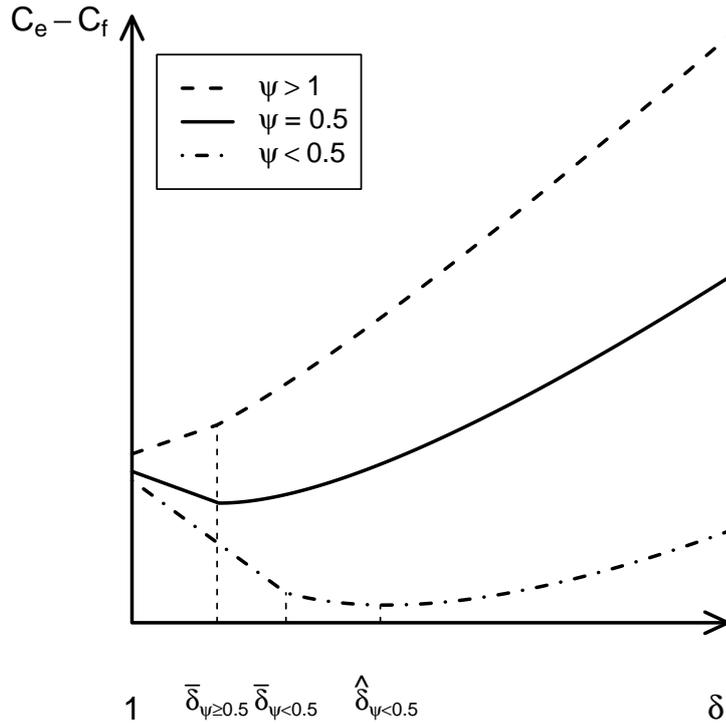


Figure 5: Relative consumption and price increases.

So in the two latter scenarios, farmers will gain in consumption relative to the elite when the rent increase is below $\hat{\delta}$. However, as the elite have greater economic resources to invest than the farmers, as δ exceeds $\hat{\delta}$, a marginal increase in rents will reduce the farmers' rent share, even in situations where they are the relatively better organized group.

To see how total farmer consumption changes with relative organizational capacity, we begin by solving (23) for the relative organizational capacity, ψ , to determine when

the farmers' budget constraint becomes binding. This gives the following closed set, with $\underline{\psi}$ the lower and $\bar{\psi}$ the upper bound

$$\psi = \left[\underbrace{\frac{\phi^{-1}\delta - 2 - ((\phi^{-1}\delta)^2 - 4\phi^{-1}\delta)^{\frac{1}{2}}}{2}}_{\underline{\psi}}, \underbrace{\frac{\phi^{-1}\delta - 2 + ((\phi^{-1}\delta)^2 - 4\phi^{-1}\delta)^{\frac{1}{2}}}{2}}_{\bar{\psi}} \right]. \quad (31)$$

from which we see that, when $\delta < 4\phi$, there is no solution, and hence, for $\delta < 4\phi$ we have an interior solution for any ψ^{13} . Hence, given some rent increase $\delta > 4\phi$, for $\underline{\psi} \leq \psi \leq \bar{\psi}$, i.e. within a given interval of relative organizational capacities, the corner solution situation applies¹⁴. Moreover, the range of ψ for which the corner solution situation applies increases with δ , since $\frac{\partial \psi}{\partial \delta} < 0$ and $\frac{\partial \bar{\psi}}{\partial \delta} > 0$ ¹⁵. Given differing time preferences, the range of ψ for a given δ , increases with $\gamma \geq 0.5$, and decreases with $\beta \geq 0.5$. The lower farmers value future consumption, compared to the elite, the smaller the range of ψ , as farmers will invest less in de facto political power at any level of δ , which means that land rents can increase further before the corner solution sets in.

Stating farmer consumption in the interior and corner solution situation gives

$$\begin{aligned} \bar{C}_f &= \beta \left(A + \left(\frac{1}{1 + \psi} \right)^2 \delta A \right) \\ \bar{C}_f^c &= \left(\frac{\gamma}{1 - \gamma} \frac{\delta}{\psi} \right)^{\frac{1}{2}} A. \end{aligned}$$

Farmer consumption is a decreasing function of ψ in the interior solution, and as $\psi \rightarrow \infty$, it follows from (23) that $\bar{\delta} \rightarrow \infty$, which means that $\delta < \bar{\delta}$ is always met, hence the corner solution never sets in. This implies that $\bar{C}_f \rightarrow \beta A$, meaning that the farmers are left with only a share of their first period income. In the corner solution situation we see that, ceteris paribus, as $\psi \rightarrow \infty$, $\bar{C}_f^c \rightarrow 0$, as the corner solution becomes infeasible.

Proposition 5 *As demonstrated in the previous section, not surprisingly, farmers can only profit from increased consumption induced by increasing land rents if they are relatively better organised than the elite. However, this only applies for lower-range land rent increases where farmers still operate in the interior solution ($\delta < 4\phi$). In order to also benefit from larger increases in land rents which result in a corner solution, farmers would need to be distinctly more effective in creating de facto political power than the elite. Even at extremely high rates of effectiveness, at some point, farmers will not be able to prevent the elite from increasing their share at the farmers' expense. Hence, farmers will only be the main beneficiaries of increases in land value in the case of small increases in rent.*

6 Summary and discussion

We analyze a baseline situation where farmers and the elite have equal time preferences and a more realistic situation which allows for differing time preferences, e.g. farmers are

¹³The lower both groups value future consumption, $\phi > 1$, the larger the increase in land rents before the corner solution sets in.

¹⁴This corresponds to the area above the curve in Figure 4. Note that $\underline{\psi}$ and $\bar{\psi}$ are always positive.

¹⁵Note that this is always positive for $\delta > 4\phi$.

more impatient than the elite. Since we assume that the farmers are relatively poor, at high enough price increases, farmers may not be able to afford to respond by increasing their expenditure on de facto political power. Hence, we further split the analysis in two; an interior solution situation, where the farmers adjust their expenditure according to the size of the price increase, and a corner solution situation, where farmers simply spend everything they have on de facto political power.

We find that in the situation where farmers are not constrained by their initial endowment, the political spending increases in the size of the price increase for both groups. In other words, when the stakes are higher, the investments are higher. This has important welfare implications, since higher prices imply that more resources are 'wasted' on obtaining de facto political power. This is in line with the conventional rent seeking explanation for the resource curse, in that the rent seeking efforts crowd out any potentially higher income derived from rents. Moreover, the distribution of land rents is given by the relative organizational capacities of the two groups, with a larger share going to the better organized group. Specifically, if the farmer group is large and socially diverse, this will, all else equal, render them less efficient in political organization, while if the elite is very wealthy and/or if the high value land is geographically concentrated, the elite will be able to appropriate a larger share of the rents.

When the farmers are budget constrained, the elite has an organizational advantage which enables them to appropriate a larger rent share, irrespective of which group is better organized. Whether or not this situation applies depends on the relative organizational capacities of the two groups and the size of the price increase, while it does not depend on the size of the farmers' initial endowment. Specifically, if the organizational capacities are highly equal, a relatively small price increase will suffice to create a situation where the farmers cannot afford to invest their preferred amount in de facto political power. This is because the optimal investment in political influence increases when the organizational capacities become more equal. That is, the more equal the two groups are at organizing, the higher the competition for rents, and the more economic resources they spend on de facto political power, and hence the smaller the overall welfare gain from increasing land rents. As a consequence, the probability of a corner solution situation increases when the organizational capacity of the two groups becomes more equal.

Lastly, it can be shown that in the event of a price increase, while the elite always gains more than the farmers when the elite is better organized, farmers will only gain more than the elite when they are the better organized group, and only for relatively low price increases (see $\hat{\delta}$). This is because, above this level, the corner solution situation sets in and prevents farmers from investing further in de facto political power.

Well functioning, i.e. democratic, political institutions may decrease the competition for rents by creating a wedge between farmers' and elite's organizational capacity, thereby reducing the level of spending on de facto political power. However, if the elite is better organized than the farmers, more effective political institutions will actually increase the welfare loss due to increasing competition for rents.

These findings suggest that in countries that have a small and wealthy elite, where the rural population is large and diverse, and where political institutions are of relatively low quality, increasing land rents may disproportionately benefit a political elite rather than the rural population. In addition, even under circumstances less severe for the farmers, if the price increase is relatively large, the elite may still be able to appropriate the lion's share, because the farmers cannot afford the political investment required to match the

elite's¹⁶. However, increasing land rents still benefit farmers in absolute terms.

Lastly, if farmers have shorter time horizons, this reduces the rent seeking efforts of both groups. However, while this increases overall consumption, it reduces the rent share which goes to the farmers.

Table 1 presents some simulated examples to give an overview of the outcome of a price increase in different situations. The column *loss/gain* gives the sum of resources spent on political influence by the two groups, divided by the total consumption after a price increase, \bar{C} . In row A and row B, farmers and the elite are equally well organized ($\psi = 1$),

Table 1: Simulated example. $\gamma = 0.5, A = 100, R = 1000$.

			F_f	F_e	p_f	p_e	C_f	C_e	\bar{C}	loss/gain
A	$\psi = 1$	$\delta = 3$								
		$\beta = \gamma = \frac{1}{2}$	75	75	0.5	0.5	175	2075	2250	0.07
B	$\psi = 1$	$\delta = 3$								
		$\beta = 0.7$	27	63	0.3	0.7	163	2147	2310	0.04
C	$\psi = 2$	$\delta = 3$								
		$\beta = 0.7$	62	145	0.18	0.82	214	2678	2892	0.07
D	$\psi = 2$	$\delta = 10$								
		$\beta = 0.7$	100	266	0.16	0.84	320	3414	3734	0.10
E	$\psi = 0.5$	$\delta = 3$								
		$\beta = 0.7$	21	50	0.67	0.33	213	2016	2229	0.03
F	$\psi = 0.5$	$\delta = 10$								
		$\beta = 0.7$	100	433	0.32	0.68	640	2935	3575	0.15

but while they have equal time preferences in situation A, farmers are more impatient in situation B. Comparing these two situations reveals that for the same increase in price ($\delta = 3$), when farmers are more impatient, they gain a smaller share of the rents (30 percent rather than 50 percent). At the same time however, the total consumption loss relative to the gain is lower when farmers are more impatient. In the situations C - F we have set $\beta = 0.7$ because, as mentioned above, farmers in developing countries often have relatively short time horizons.

Situation C could represent the situation that occurred in Ghana and the Ivory Coast just after independence. Both countries were large producers of coffee and cocoa, and at the time of independence, these commodities represented a potentially valuable export commodity for the two countries. However, the farmers were very badly organized (e.g. Easterly and Levine, 1997; Bates and Block, 2009) and in addition, institutions regulating land and property rights were not functioning well (represented by $\psi > 1$). While this has resulted in a low rent share going to the farmers, the overall welfare loss due to rent seeking has been modest (e.g. Acemoglu et al., 2003).

Situation E could represent the events in Malaysia under the palm oil boom between the 1960s and the 1980s (see e.g. Fold and Whitfield, 2012). In Malaysia, farmers were poor, but they were also relatively well organized, while the elite was not too well organized and did not possess a large amount of wealth. In addition, institutions were relatively well functioning ($\psi = 0.5$) (e.g. Abidin, 2005). Hence, under the palm oil boom, farmers were able to organize and gain a relatively large share of the rents without

¹⁶It should be noted that this is under the assumption of no, or imperfect, credit markets, i.e. farmers cannot borrow against future income from land rents.

wasting too many resources on de facto political power, thereby benefiting the farmers as well as the general economy (in terms of a relatively low welfare loss-to-gain ratio).

Situation F could for example illustrate the, rather extreme, situation of an exogenous price shock to coca production in Columbia in 1994. In 1994 the Andean air bridge, which ferried coca paste from growers in neighboring countries to Columbian refiners, was disrupted, leading to significant price (and production) increases of coca in Columbia (Angrist and Kugler, 2008). Moreover, it can be argued that Columbian farmers were highly organized (e.g. via the FARC¹⁷ and other paramilitary groups), and, according to Angrist and Kugler (2008), the coca price shock increased violence in the rural areas producing coca and created rent-seeking, limiting the overall economic gains from coca.

Comparing this to situation D, where the size of the price increase is the same, but where the elite is highly organized, the welfare loss-to-gain ratio is smaller in situation D. This is because competition is reduced when farmers are not very politically effective, and hence, the elite does not have to spend as much on de facto political power.

7 Conclusion

We have developed a model that analyzes the effects of increasing land rents in land abundant developing countries. The main focus has been on the distributional consequences of increasing land rents between different groups in society. The model identifies the circumstances under which an increase in land rents leads to the appropriation of land rents by the elite. Our findings suggest, that the crucial determinants include the relative organizational capacity of the two groups, and consequently their ability to generate de facto political power within a given set of political institutions, and the extent of the increase in land. In particular, high organizational capacity of farmers may have adverse effects because it can generate an incentive for the elite to increase political investment to a point where the farmers are unable to compete.

According to the model, farmers will in general benefit from increasing land rents. However, since many land abundant developing countries are often characterized by low quality political institutions, large and diverse rural populations, and small and wealthy elites, the likelihood of small scale farmers being able to reap the larger share of the benefits from increases in land value is relatively low. In addition, if the farmers are relatively well organized, approaching the organizational capacity of the elite, large amounts of resources will be wasted on rent seeking by both groups, which will, everything else equal, reduce the potential welfare gain from higher land rents.

An obvious policy recommendation for land abundant developing countries facing increasing land rents would be to improve the quality of their political institutions. However, this may be a slow and tedious process. A second best alternative would be to augment farmers' cooperation and to reduce tension between different ethnic groups, e.g. by increasing generalized trust and investing in rural infrastructure.

Our model is, of course, a simplified version of the real world, i.e. in order to demonstrate our main point we chose to abstract from less central aspects. However, we propose the following potential extensions: in line with Hirshleifer (1991), the production side of the economy could be included in order to account for alternative activities to which resources could be allocated, and to enable the analysis of economic development effects

¹⁷Which was a farmers' defense coalition formed in the 1950s to resist the minority conservative government.

in general. Moreover, modeling the production side would facilitate the disentanglement of the distributional effects of different crops (Arndt et al., 2009). Secondly, the two-period set up could be changed to facilitate a more dynamic analysis. For example, this would enable a more precise analysis of the interaction effects between economic and political superiority. Thirdly, enabling the farmers to appropriate rents from point source resources would make the model more general, and facilitate a more general analysis of the relationship between de facto political power and natural resource rent appropriation. Moreover, extending the model to include a greater number of groups may also provide interesting insights, e.g. including the organizational capacity of an urban population could be expected to have implications for the distributional outcome. Lastly, the inclusion of capital markets would have strong implications on the decision making process of both farmers and the elite in a dynamic setting.

A Mathematical appendix

A.1 Utility maximization of farmers and elite

We use the Karush-Kuhn-Tucker (KKT) approach to solve the farmers' and the elite's utility maximization problem. First write up the problem in the general form

$$\min f(x) \tag{32}$$

$$\text{s.t.} \quad -x \leq 0 \tag{33}$$

$$x - c \leq 0 \tag{34}$$

If the problem is convex the following KKT conditions are necessary and sufficient conditions for optimum, if not, they are necessary:

$$-x \leq 0 \tag{35}$$

$$x - c \leq 0 \tag{36}$$

$$\lambda_1 \geq 0 \tag{37}$$

$$\lambda_2 \geq 0 \tag{38}$$

$$-\lambda_1 x = 0 \tag{39}$$

$$\lambda_2(x - c) = 0 \tag{40}$$

where λ_1 and λ_2 are the Lagrange multipliers, one for each constraint. Translating this into our farmer problem gives

$$\min \quad -\beta C_t + (\beta - 1)C_{t+1} \tag{41}$$

$$\text{s.t.} \quad C_t = A - F_f \tag{42}$$

$$C_{t+1} = p_{t+1}\delta A \tag{43}$$

$$p_{t+1} = \frac{mn^{1-\alpha}F_f}{mn^{1-\alpha}F_f + m^{-1}RkF_e} \tag{44}$$

$$C_t, C_{t+1}, F_f, p_{t+1} \geq 0 \tag{45}$$

First we reduce the problem by noting that if we assume $F_f \geq 0$ then we also have $p_{t+q} \geq 0$ from (44) (since $m, n^{1-\alpha}, R, k, F_e \geq 0$), and if $p_{t+q} \geq 0$ then we also have $C_{t+1} \geq 0$ from

(43) (since $\delta A \geq 0$). Therefore, we can reduce the problem to the following

$$\min_{F_f} \quad -\beta(A - F_f) + (\beta - 1) \frac{mn^{1-\alpha}\delta AF_f}{mn^{1-\alpha}F_f + m^{-1}RkF_e} \quad (46)$$

$$\text{s.t.} \quad -F_f \leq 0 \quad (47)$$

$$F_f - A \leq 0 \quad (48)$$

Hence, if the constraints (47) and (48) holds, all the constraints in the original problem ((42) to (45)) also holds. Reformulating the KKT conditions above we get

$$-F_f \leq 0 \quad (49)$$

$$F_f - A \leq 0 \quad (50)$$

$$\lambda_1 \geq 0 \quad (51)$$

$$\lambda_2 \geq 0 \quad (52)$$

$$-\lambda_1 F_f = 0 \quad (53)$$

$$\lambda_2 (F_f - A) = 0 \quad (54)$$

If these conditions are met we have necessary conditions for optimum. If the problem is convex, these conditions are also sufficient.

We set up the Lagrangian

$$L = -\beta(A - F_f) + (\beta - 1) \frac{mn^{1-\alpha}F_f\delta A}{mn^{1-\alpha}F_f + m^{-1}RkF_e} + \lambda_1(-F_f) + \lambda_2(F_f - A)$$

Differentiating this w.r.t. F_f gives

$$\beta + (\beta - 1) \frac{n^{1-\alpha}Rk\delta AF_e}{(mn^{1-\alpha}F_f + m^{-1}RkF_e)^2} - \lambda_1 + \lambda_2 = 0 \quad (55)$$

Now we will evaluate the three situations, $F_f = 0$, $F_f = A$ and $0 < F_f < A$.

First we look at $F_f = 0$: in this case we know from (54) that $\lambda_2 = 0$. Substituting $F_f = \lambda_2 = 0$ into (55) we get

$$\lambda_1 = \beta + (\beta - 1) \frac{mn^{1-\alpha}\delta A}{m^{-1}RkF_e} \quad (56)$$

Which, according to (51) must be ≥ 0 . Hence, we get

$$\delta \leq \frac{\beta}{1 - \beta} \frac{m^{-1}RkF_e}{mn^{1-\alpha}A}$$

When the above holds, we have $F = 0$, and the KKT conditions (49) to (54) are satisfied.

Second, we look at the situation $F_f = A$. In this case, from (53) we must have $\lambda_1 = 0$. Substituting this into (55) we get

$$\lambda_2 = (1 - \beta) \frac{n^{1-\alpha}Rk\delta AF_e}{(mn^{1-\alpha}A + m^{-1}RkF_e)^2} - \beta \quad (57)$$

Which according to (52) must be ≥ 0 , giving

$$\begin{aligned} \frac{n^{1-\alpha}Rk\delta AF_e}{(mn^{1-\alpha}A + m^{-1}RkF_e)^2} &\geq \frac{\beta}{1 - \beta} \\ \Leftrightarrow \delta &\geq \frac{\beta}{1 - \beta} \frac{(mn^{1-\alpha}A + m^{-1}RkF_e)^2}{n^{1-\alpha}RkAF_e} \end{aligned} \quad (58)$$

Hence when $F = A$, the above must be satisfied, and the rest of the KKT conditions are also satisfied.

Lastly we have the situation where $0 < F_f < A$. In this situation, from (53) and (54) we must have $\lambda_1 = \lambda_2 = 0$. Substituting this into (55) we get

$$\frac{\beta}{1-\beta} = \frac{n^{1-\alpha} Rk \delta A F_e}{(mn^{1-\alpha} F_f + m^{-1} Rk F_e)^2}$$

$$\Leftrightarrow mn^{1-\alpha} F_f + m^{-1} Rk F_e = \left(\frac{1-\beta}{\beta} n^{1-\alpha} Rk \delta A F_e \right)^{\frac{1}{2}}$$

since we know $\frac{1-\beta}{\beta} n^{1-\alpha} Rk \delta A F_e > 0$, giving

$$F_f = \left(\frac{1-\beta}{\beta} \right)^{\frac{1}{2}} \frac{(n^{1-\alpha} Rk \delta A F_e)^{\frac{1}{2}}}{mn^{1-\alpha}} - \frac{m^{-1} Rk F_e}{mn^{1-\alpha}}$$

This is the reaction function of the farmers, and, when substituting $\psi = \frac{m^{-1} Rk}{mn^{1-\alpha}}$, can be reduced to

$$F_f = \left(\frac{1-\beta}{\beta} \delta A \psi F_e \right)^{\frac{1}{2}} - \psi F_e. \quad (59)$$

Similarly we write up the problem of the elite

$$\min \quad -\gamma C_{e,t} + (\gamma - 1) C_{e,t+1} \quad (60)$$

$$\text{s.t.} \quad C_{e,t} = R - F_{e,t} \quad (61)$$

$$C_{e,t+1} = R + p_{e,t+1} \delta A \quad (62)$$

$$p_{e,t+1} = \frac{m^{-1} Rk F_{e,t}}{mn^{1-\alpha} F_{f,t} + m^{-1} Rk F_{e,t}} \quad (63)$$

$$C_{e,t}, C_{e,t+1}, F_{e,t}, p_{e,t+1} \geq 0 \quad (64)$$

As with the farmers utility maximisation we can reduce this problem to one with only two constraints, $-F_{e,t} \leq 0$ and $F_{e,t} - R \leq 0$. Since we assume that R is very large (and specifically $A \ll R$), we will assume that $F_{e,t} - R$ is always negative, leaving us with an unconstrained optimization problem for the elite.

Optimization of the system (60) to (64) gives the reaction function of the elite

$$F_{e,t} = \left(\frac{1-\gamma}{\gamma} \frac{mn^{1-\alpha} \delta A}{m^{-1} Rk} F_f \right)^{\frac{1}{2}} - \frac{mn^{1-\alpha}}{m^{-1} Rk} F_f \quad (65)$$

and substituting $\psi = \frac{m^{-1} Rk}{mn^{1-\alpha}}$ gives

$$F_{e,t} = \left(\frac{1-\gamma}{\gamma} \delta A \frac{1}{\psi} F_{f,t} \right)^{\frac{1}{2}} - \frac{1}{\psi} F_{f,t} \quad (66)$$

A.2 Corner solution condition

To find the threshold value of δ above which the farmers' budget constraint is binding, substitute $F_{f,t} = A$ into (65)

$$F_{e,t} = \left(\frac{1-\gamma}{\gamma} \right)^{\frac{1}{2}} \left(\frac{mn^{1-\alpha} \delta (A)^2}{m^{-1} Rk} \right)^{\frac{1}{2}} - \frac{mn^{1-\alpha} A}{m^{-1} Rk}$$

and substituting this into (58) gives

$$\delta \geq \frac{\beta}{1-\beta} \frac{\left(mn^{1-\alpha}A + m^{-1}Rk \left[\left(\frac{1-\gamma}{\gamma} \right)^{\frac{1}{2}} \left(\frac{mn^{1-\alpha}\delta(A)^2}{m^{-1}Rk} \right)^{\frac{1}{2}} - \frac{mn^{1-\alpha}A}{m^{-1}Rk} \right] \right)^2}{n^{1-\alpha}RkA \left[\left(\frac{1-\gamma}{\gamma} \right)^{\frac{1}{2}} \left(\frac{mn^{1-\alpha}\delta(A)^2}{m^{-1}Rk} \right)^{\frac{1}{2}} - \frac{mn^{1-\alpha}A}{m^{-1}Rk} \right]} \quad (67)$$

$$= \frac{\beta}{1-\beta} \frac{\left(\left(\frac{1-\gamma}{\gamma} \right)^{\frac{1}{2}} (n^{1-\alpha}Rk\delta)^{\frac{1}{2}} A \right)^2}{\left(\frac{1-\gamma}{\gamma} \right)^{\frac{1}{2}} n^{1.5(1-\alpha)} (Rk\delta)^{\frac{1}{2}} m(A)^2 - (mn^{1-\alpha}A)^2} \quad (68)$$

$$= \frac{\beta}{1-\beta} \frac{1-\gamma}{\gamma} \frac{Rk\delta}{m \left(\left(\frac{1-\gamma}{\gamma} \right)^{\frac{1}{2}} (n^{1-\alpha}Rk\delta)^{\frac{1}{2}} - mn^{1-\alpha} \right)} \quad (69)$$

$$\Leftrightarrow \left(\frac{1-\gamma}{\gamma} \right)^{\frac{1}{2}} (n^{1-\alpha}Rk\delta)^{\frac{1}{2}} - mn^{1-\alpha} \geq \frac{\beta}{1-\beta} \frac{1-\gamma}{\gamma} m^{-1}Rk \quad (70)$$

$$\Leftrightarrow (n^{1-\alpha}Rk\delta)^{\frac{1}{2}} \geq \frac{\beta}{1-\beta} \left(\frac{1-\gamma}{\gamma} \right)^{\frac{1}{2}} m^{-1}Rk + \left(\frac{\gamma}{1-\gamma} \right)^{\frac{1}{2}} mn^{1-\alpha} \quad (71)$$

$$\Leftrightarrow \delta \geq \frac{\left(\frac{\beta}{1-\beta} \left(\frac{1-\gamma}{\gamma} \right)^{\frac{1}{2}} m^{-1}Rk + \left(\frac{\gamma}{1-\gamma} \right)^{\frac{1}{2}} mn^{1-\alpha} \right)^2}{n^{1-\alpha}Rk} \quad (72)$$

$$\Leftrightarrow \delta \geq \left(\frac{\beta}{1-\beta} \right)^2 \frac{\gamma}{1-\gamma} \frac{\left(\frac{1-\gamma}{\gamma} m^{-1}Rk + \frac{1-\beta}{\beta} mn^{1-\alpha} \right)^2}{n^{1-\alpha}Rk} \quad (73)$$

which can be rewritten

$$\delta \geq \frac{\beta}{1-\beta} \left(\frac{\beta}{1-\beta} \frac{1-\gamma}{\gamma} \psi + 2 \right) + \frac{\gamma}{1-\gamma} \frac{1}{\psi}$$

A.3 Comparative statics

A.3.1 Equilibrium spending and political institutions

Differentiating (17) wrt. m we get

$$\begin{aligned} \frac{\partial F^*}{\partial m} &= \frac{-2m^{-3}Rkn^{-(1-\alpha)}\delta A\phi^{-1}}{(1+m^{-2}Rkn^{-(1-\alpha)})^2} + \frac{-2m^{-2}Rkn^{-(1-\alpha)}\delta A\phi^{-1} * -2m^{-3}Rkn^{-(1-\alpha)}}{(1+m^{-2}Rkn^{-(1-\alpha)})^3} \\ &= \frac{2m^{-5}(Rk)^2n^{-2(1-\alpha)}\delta A\phi^{-1} - 2m^{-3}Rkn^{-(1-\alpha)}\delta A\phi^{-1}}{(1+m^{-2}Rkn^{-(1-\alpha)})^3} \end{aligned}$$

which is negative when

$$\begin{aligned} 2m^{-5}(Rk)^2n^{-2(1-\alpha)}\delta A\phi^{-1} &< 2m^{-3}Rkn^{-(1-\alpha)}\delta A\phi^{-1} \\ \Leftrightarrow m^{-1}Rk &< mn^{1-\alpha} \\ \Leftrightarrow \psi &< 1 \end{aligned}$$

The derivative of (17) wrt. R and k is positive when $\psi < 1$. Hence, when farmers are the better organized group, a higher value of point source resources and/or a larger degree of concentration of arable land increases spending by both groups, because it reduces the gap between organizational capacities.

A.4 Consumption

A.4.1 Interior solution

In the interior solution, total farmer consumption is given by

$$\begin{aligned}\bar{C}_f &= A - F_f + p_f \delta A = A - \frac{\gamma}{1 - \gamma} \frac{\psi}{\left(\frac{\gamma}{1-\gamma} + \frac{\beta}{1-\beta} \psi\right)^2} \delta A + \frac{\frac{\gamma}{1-\gamma}}{\frac{\gamma}{1-\gamma} + \frac{\beta}{1-\beta} \psi} \delta A \\ &= A - \frac{\frac{\gamma}{1-\gamma} \delta A}{\frac{\gamma}{1-\gamma} + \frac{\beta}{1-\beta} \psi} \left(\frac{\psi}{\frac{\gamma}{1-\gamma} + \frac{\beta}{1-\beta} \psi} - 1 \right)\end{aligned}\quad (74)$$

and total elite consumption is

$$\begin{aligned}\bar{C}_e &= 2R - F_e + p_e \delta A = 2R - \frac{\beta}{1 - \beta} \frac{\psi}{\left(\frac{\gamma}{1-\gamma} + \frac{\beta}{1-\beta} \psi\right)^2} \delta A + \frac{\frac{\beta}{1-\beta} \psi}{\frac{\beta}{1-\beta} \psi + \frac{\gamma}{1-\gamma}} \delta A \\ &= 2R + \frac{\frac{\beta}{1-\beta} \psi}{\frac{\gamma}{1-\gamma} + \frac{\beta}{1-\beta} \psi} \left(1 - \frac{1}{\frac{\gamma}{1-\gamma} + \frac{\beta}{1-\beta} \psi} \right) \delta A\end{aligned}\quad (75)$$

Subtracting (74) from (75) gives relative consumption

$$\begin{aligned}\bar{C} &= \bar{C}_e - \bar{C}_f = 2R + \frac{\frac{\beta}{1-\beta} \psi \delta A}{\frac{\gamma}{1-\gamma} + \frac{\beta}{1-\beta} \psi} \left(1 - \frac{1}{\frac{\gamma}{1-\gamma} + \frac{\beta}{1-\beta} \psi} \right) \\ &\quad - A + \frac{\frac{\gamma}{1-\gamma} \delta A}{\frac{\gamma}{1-\gamma} + \frac{\beta}{1-\beta} \psi} \left(\frac{\psi}{\frac{\gamma}{1-\gamma} + \frac{\beta}{1-\beta} \psi} - 1 \right) \\ &= 2R - A + \frac{\delta A}{\left(\frac{\gamma}{1-\gamma} + \frac{\beta}{1-\beta} \psi\right)^2} \left(\left(\frac{\beta}{1-\beta}\right)^2 \psi^2 - \left(\frac{\gamma}{1-\gamma}\right)^2 + \psi \left(\frac{\gamma}{1-\gamma} - \frac{\beta}{1-\beta}\right) \right)\end{aligned}\quad (76)$$

A.4.2 Corner solution

In the corner solution we have that $F_f^* = A$ and $F_e^* = \left(\frac{1-\gamma}{\gamma} \delta \frac{1}{\psi}\right)^{\frac{1}{2}} A - \frac{1}{\psi} A$. Moreover, we have $p_f^c = \left(\frac{\gamma}{1-\gamma} \frac{1}{\psi \delta}\right)^{\frac{1}{2}}$ and $p_e^c = 1 - \left(\frac{\gamma}{1-\gamma} \frac{1}{\psi \delta}\right)^{\frac{1}{2}}$.

Hence, total farmer consumption in the corner solution is

$$\bar{C}_f^c = A - F_f^c + p_f^c \delta A = A - A + \left(\frac{\gamma}{1-\gamma} \frac{1}{\psi \delta}\right)^{\frac{1}{2}} \delta A = \left(\frac{\gamma}{1-\gamma} \frac{\delta}{\psi}\right)^{\frac{1}{2}} A \quad (77)$$

Moreover, total elite consumption is

$$\begin{aligned}\bar{C}_e^c &= R - F_e^c + p_e^c \delta A + R = 2R - \left(\frac{1-\gamma}{\gamma} \frac{\delta}{\psi}\right)^{\frac{1}{2}} A + \frac{1}{\psi} A + \left(1 - \left(\frac{\gamma}{1-\gamma} \frac{\delta}{\psi}\right)^{\frac{1}{2}}\right) \delta A \\ &= 2R + A \left(\frac{1}{\psi} + \delta - \left(\frac{\delta}{\psi}\right)^{\frac{1}{2}} \left(\left(\frac{1-\gamma}{\gamma}\right)^{\frac{1}{2}} + \left(\frac{\gamma}{1-\gamma}\right)^{\frac{1}{2}} \right) \right)\end{aligned}\quad (78)$$

Subtracting (77) from (78) we get relative consumption in the corner solution

$$\begin{aligned}
\bar{C}^c &= \bar{C}_e - \bar{C}_f = 2R + A \left(\frac{1}{\psi} + \delta - \left(\frac{\delta}{\psi} \right)^{\frac{1}{2}} \left(\left(\frac{1-\gamma}{\gamma} \right)^{\frac{1}{2}} + \left(\frac{\gamma}{1-\gamma} \right)^{\frac{1}{2}} \right) \right) \\
&\quad - \left(\frac{\gamma}{1-\gamma} \right)^{\frac{1}{2}} \left(\frac{\delta}{\psi} \right)^{\frac{1}{2}} A \\
&= 2R + A \left(\frac{1}{\psi} + \delta - \left(\frac{\delta}{\psi} \right)^{\frac{1}{2}} \left(\left(\frac{1-\gamma}{\gamma} \right)^{\frac{1}{2}} + 2 \left(\frac{\gamma}{1-\gamma} \right)^{\frac{1}{2}} \right) \right)
\end{aligned} \tag{79}$$

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