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The Distributional Consequences of Rent Seeking

Abstract

Rent seeking leads to a misallocation of resources that worsens economic outcomes and reduces aggregate welfare. We conduct a quantitative examination of the distributional effects of rent extraction via the financial sector. Rent seeking introduces a possibility for insurance against idiosyncratic earnings risk that is more valuable for poorer households that are lacking in means of self insurance. However, it also creates a wedge that discourages savings, thus reducing self insurance via asset accumulation. When the model is calibrated to US data, the distorting effects dominate, implying welfare losses for all households, and an increase in wealth inequality. Nevertheless, welfare losses are bigger for households with higher initial wealth. Therefore, a policy reform to reduce rent seeking via the financial sector, despite being Pareto improving, will benefit predominantly wealthier households.

JEL-Codes: E020, D310, H100.

Keywords: conditional welfare changes, wealth distribution, rent seeking.

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1 Introduction

The importance of institutional quality for economic outcomes is widely accepted (see e.g. North (1990), Hall and Jones (1999), Rodrik *et al.* (2004), Acemoglu (2009) and Acemoglu and Robinson (2019)). An expression of weak institutions is rent seeking. Rent seeking is typically defined as "the socially costly pursuit of income and wealth transfers" (Drazen (2000, p. 335)) and can take many forms, ranging from access to lucrative opportunities by influencing decisions through the hiring of lawyers and lobbyists, to extra transfers and subsidies from state coffers. Rent seeking activities imply social costs, efficiency losses and lower economic performance at the aggregate level (see e.g. North (1990), Drazen (2000), Mueller (2003), and Acemoglu (2009)). When households are heterogeneous, welfare losses associated with rent seeking need not be symmetric, and financial rent seeking may also contribute to inequality.[1] The importance of incomplete financial markets is central in the analysis of inequality, because it links earnings inequality driven by idiosyncratic productivity shocks to wealth inequality (see e.g. Bewley (1986), Huggett (1993) and Aiyagari (1994); and Krueger *et al.* (2016) for a review of relevant research).

In this paper, we examine the distribution of welfare gains or losses that results from rent extraction via the financial sector across the population, and conditional on initial wealth and earnings, and the impact of such rent seeking on wealth inequality. We focus on rent seeking related to the financial sector[2] because financial markets are central in the transmission of earnings risk to wealth inequality, but also because of the importance of financial markets in modern economies, in general, and in terms of rent extraction, more specifically (e.g. Philippon (2012) and Mazzucato (2018)). To examine quantitatively the impact of financial rent seeking on the distribution of wealth and of welfare losses across the population, we extend, in a tractable way, an incomplete markets model to allow for rent seeking from the financial sector. We assume that, because of weak institutions, a share of aggregate savings that the financial market has collected can be diverted away from production to households' income. For example, this captures assets which are circulated, via the financial market, between households, and imply income not associated with a productive activity, e.g. some returns from trading in the stock market, or from using financial instruments, or via

[1] See e.g. Acemoglu *et al.* (2015) for a review of the literature discussing different winners and losers from rent seeking. We contextualise our work relative to the literature in the next section.

[2] Therefore, we do not study the distributional effects of rent seeking from other sectors (e.g. rent seeking related to government intervention), which may be different.

transactions in estate that do not reflect an increase in production; or loans at a preferentially low rate; or some bonuses/payments and other privileges and expenses paid out to managers/shareholders/customers. Households acquire a share of these resources via rent seeking competition which requires the intermediation of an additional sector that provides lobbying or extraction services.

More specifically, our model is an extension of the incomplete markets model with production of Aiyagari (1994), which is the baseline model for quantitative analysis of wealth inequality under idiosyncratic shocks. We assume that exogenous weak institutions create a contestable pie, comprised of a proportion of aggregate savings, over which households compete with each other for a share in a Tullock (1967) type contest. Extraction increases with relative wealth, capturing the intuition that wealthier households are in a better position to benefit from financial rent seeking.[3] More generally, it is recognised that rent-seeking competition favours elites (see e.g. the literature reviewed in Acemoglu *et al.* (2015)), which are typically associated with agents with higher relative wealth, who for example may have a better insider position in financial markets. However, rent seeking comes at a private cost, in that each household needs to spend part of the proceeds from rent seeking as fees to an intermediation sector, capturing the services of law, financial, or lobbying firms. Lobbying firms utilise labour to provide rent seeking services. At the level of the household, the cost of such services is fixed and the pool of contestable resources is taken as given. In general equilibrium, however, rent seeking reduces capital and labour available for productive uses and leads to a deterioration of aggregate outcomes.

In this environment, there are two opposite effects from rent seeking. On one hand, a rent-seeking competition where rent extraction is a positive function of one's wealth, incentivises individuals to accumulate wealth, which in turn reduces their exposure to the idiosyncratic component of their incomes and hence reduces the spread of actual incomes and decisions for savings across households. In other words, financial rent seeking provides a means of insurance, which, in an incomplete market environment, works to correct the incompleteness of the financial market. According to this channel, rent seeking tends to reduce wealth inequality and to increase welfare.

On the other hand, rent seeking sets in motion an opposite, general equilibrium, sequence of effects to the one just described. Rent seeking typically diverts resources away from productive activities, so that in general equi-

[3] In particular, we consider the case where extraction is a smooth increasing function of own wealth, and the situation where participation in rent seeking can only take place above a threshold level of own wealth.

librium it worsens aggregate outcomes. In particular, it reduces the market return to savings and individuals' income and hence individuals' ability to increase their savings and wealth. The reduction in income from savings increases the exposure of households to the idiosyncratic component of their incomes and consequently also increases the spread of actual incomes and decisions for savings across households. According to this channel, rent seeking tends to increase wealth inequality and to decrease welfare.

Our research questions are thus motivated by the acknowledgement that rent seeking has an implicit insurance value, together with resource misallocation effects. First, because this implies that it is not evident that wealth inequality increases with a deterioration of institutions, even when the quantity of resources that each agent extracts is increasing in his/her own wealth, as we assume here. Moreover, both the insurance value and the effects of resource misallocation matter differently for households across the wealth and earnings distributions, implying that the welfare changes associated with a weakening of institutions (or, equivalently, an increase in rent seeking) need not be distributed equally over the cross section of households. In particular, we ask three questions relating to the distributional effects of financial rent seeking. Does wealth inequality increase as a result of a worsening in institutional quality that leads to increased financial rent seeking? Do all households lose when aggregate welfare is reduced due to the increase in financial rent seeking? And, are welfare gains/losses increasing or decreasing in initial wealth and earnings? In turn, these allow us to study the distributional implications of policy reforms to improve institutions and reduce financial rent seeking.

We answer these questions quantitatively, by calibrating the model to the U.S.A., for a base level of institutional quality that allows for 1% of aggregate savings to be extracted via the rent seeking competition. This calibration implies that the labour misallocation that is due to rent seeking intermediation, via the lobbying sector, absorbs 3.5% of the labour force, which is about half of the share of the labour force that works in "Legal occupations" and "Business and financial operations".[4] We then consider a gradual deterioration of institutional quality, that follows a deterministic path, up to the level that it allows for 2% of aggregate savings to be extracted via the rent seeking competition. We compute the dynamic path for the economy and distributional outcomes, and the distribution of conditional welfare gains/losses under these dynamic paths, under perfect foresight regarding the evolution

[4] This statistic is obtained using data from the Current Population Survey. As discussed later, the model predictions in this case are also consistent with alternative approximations of aggregate consumption losses due to rent seeking, and the spread between the return to capital and the safe real short rate.

of the aggregate quantities. We also compute these outcomes under a reform that gradually improves institutions, to eliminate financial rent seeking.

We find that wealth inequality increases over time to a new, higher level. Indeed, a negative relationship between wealth inequality and the quality of institutions is consistent with empirical observation from a time series for the U.S. economy (see Figure 1 in the analysis of the results). We also confirm that the negative relationship between institutional quality and wealth inequality is driven by the disincentives to save associated with the general equilibrium resource misallocation effects. By contrast, we find that at the individual level or equivalently in partial equilibrium, weaker financial institutions and higher rent seeking imply lower wealth inequality (Figures 2-4).

The intuition behind these effects is that returns to savings are increased at the level of the individual household, who does not internalise the effects of his/her own rent seeking on aggregate outcomes, and thus rent seeking opportunity works effectively as a way to improve self-insurance. Hence, abstracting from general equilibrium aggregate outcomes, assuming that the financial system allows the wealthy to extract more implies in fact lower wealth inequality. However, in general equilibrium, the resource misallocation effects associated with rent seeking reduce market returns, so that savings are reduced, and thus households are more exposed to idiosyncratic earnings shocks. Putting aggregate and distributional effects together, rent seeking changes the wealth distribution by shifting its mean to the left, while increasing its implied inequality. Therefore, the general equilibrium effect dominates and so rent seeking is a mechanism that amplifies the effect of earnings inequality on wealth inequality.

We compute the welfare losses (in terms of expected lifetime utility) over the dynamic path that the aggregate economy follows given the worsening in institutional quality, across the distribution, and conditional on initial wealth and earnings (Figure 5). We find that an increase in rent seeking implies welfare losses for all levels of initial wealth and earnings. For any given level of initial earnings, welfare losses are higher for households with higher initial level of wealth; and, for any given initial level of wealth, welfare losses are higher for households with higher initial level of earnings. This finding is important because it implies that financial rent seeking is detrimental to all, albeit more so for those with higher wealth and earnings. And vice versa, policy reforms to improve institutions to reduce financial rent seeking are Pareto improvements, but will mainly benefit the richer households.

This result implies that the reduction in self-insurance caused by wedge to the returns to savings that financial rent seeking creates is more important, quantitatively, than the additional possibilities for insurance that financial rent seeking generates, for all households. At a partial equilibrium level, financial rent seeking is beneficial to all, because it provides an additional means of insurance against earnings risk. These gains are higher for poorer households, who have lower means for self insurance. However, the distortions at the general equilibrium level create disincentives to save (and thus to self-insure against idiosyncratic earnings risk), caused by the reduction in returns to savings due to financial rent seeking. These effects are strong enough to overturn the direct insurance benefits of financial rent seeking.

The rest of the paper is organised as follows. After contextualising our work relative to the existing research in Section 2, in section 3, we set out the incomplete markets, heterogeneous agents model with financial rent seeking. Then, in Section 4, we discuss calibration and computation, and in Section 5 we analyse the results on the link between increased rent seeking and wealth inequality. In section 6 we analyse the distribution of conditional welfare changes following changes in the quality of institutions. In Section 7 we analyse further dimensions of the economic environment that matter for the distributional implications of rent seeking and we summarise with conclusions in Section 8. Finally, in an Appendix, we present a simple example with analytical solution to aid the presentation of the intuition behind the relationship between rent seeking and wealth inequality in general equilibrium.

2 Relevant literature

A vast literature has shown that earnings inequality, and in particular idiosyncratic shocks to earnings under incomplete financial markets, generate wealth inequality in a general equilibrium framework based on seminal contributions by Bewley (1986), Imrohoroglu (1989), Huggett (1993) and Aiyagari (1994). In this class of models, a continuum of economic agents receives idiosyncratic earnings shocks against which they cannot fully insure. As a result, earnings shocks pass through to income, and hence differences in histories of idiosyncratic earnings create different opportunities for accumulating assets. In other words, earnings inequality is propagated, via incomplete financial markets, to wealth inequality.

Quantitative analysis of wealth inequality based on this literature, and the benchmark model in Aiyagari (1994) in particular, captures important qualitative properties of the wealth distribution in the data, but it underpredicts inequality quantitatively, especially at the top end of the wealth distribution. Wealth is indeed not distributed equally across the population. A significant body of research has provided robust empirical evidence that the distribution of wealth is very skewed and that wealth inequality is higher than earnings inequality (see e.g. Krueger *et al.* (2016), Quadrini and Rios-Rull (2015) and Kuhn and Rios-Rull (2016)). As a result, the literature has considered many extensions that improve the predictions of the model, often focusing on improving wealth inequality predictions at the top percentiles (see e.g. the reviews in Krueger *et al.* (2016), Benhabib *et al.* (2017) and Benhabib and Bisin (2018)). Here, we consider the role of institutional quality and rent seeking in particular, and how changes in the latter affect inequality.

There has been a rich and still expanding literature on the relationship between institutional quality, the distribution of power and the degree of inequality (see e.g. the literature reviewed in Karabarbounis (2011) and Acemoglu *et al.* (2015)). Regarding modelling, the most popular way to model weak institutions and rent seeking is to assume that private and/or communal properties are "common pools". Access to the latter distorts individual incentives by pushing atomistic agents to a rent seeking competition over a share of the common pool, which leads to resource misallocation and eventually to poor macroeconomic performance. The literature also suggests that differences in wealth create different abilities for resource extraction and rent seeking (e.g. Acemoglu *et al.* (2015)). This may happen because a higher relative wealth relates to a better insider position in financial or other markets and more status or power in the sociopolitical system.[5] The link between rent seeking and inequality has also been examined (see e.g. Chakraborty and Dabla-Norris (2006) and Chaturvedi (2017)), primarily focusing on income inequality in static or two period models. Here, we focus on rent seeking related to the financial sector, its quantitative effects on the distribution of wealth, and the evaluation of the distribution of welfare losses following a worsening of institutional quality (and thus an increase in rent seeking) conditional on initial wealth and earnings, under idiosyncratic productivity. This requires that we work with a stochastic dynamic framework, and thus that we incorporate rent seeking in a tractable fashion. The stochastic environment can capture the role of earnings risk and the inter-temporal dimension can allow for endogenous wealth accumulation.

A related research programme has examined the distributional implications of fiscal policy reforms in this class of models, by computing conditional welfare gains/losses for households with different initial conditions, over a deterministic dynamic path for policy instruments (e.g. Domeij and Heathcote (2004), and Kitao (2008)). Here we focus on the evaluation of conditional

[5]The relationship between wealth and status has been analysed both historically (e.g. Mokyr (1985) and Perkin (1969)) and regarding its importance for economic outcomes (e.g. Cole *et al.* (1992)).

welfare losses/gains associated with a deterioration of the quality of institutions (and of a policy reform to improve institutions), implying an increase (decrease) in rent seeking via the financial sector. Given that the quality of institutions and the implied rent seeking effectively work partly as an effective tax on asset income (in general equilibrium), and partly as an additional insurance mechanism (in partial equilibrium), there are parallels between our results and those in the literature on taxation. Welfare losses from financial rent seeking, due to the wedge to the returns to savings that it implies, increase with initial wealth, similar to the effect of taxes on capital income documented in some studies (e.g. Kitao (2008)). In our model, we find that policy reforms to remove this wedge are Pareto improving, despite the insurance benefits it provides for poorer households.

The institutional framework regarding the financial market is at the heart of most heterogeneous agent models. In particular, it is typically assumed that financial markets are incomplete and that their role is to transfer savings from households to firms. There has been research that aims to endogenise financial market imperfections in this framework, and, more generally, to allow for a more realistic insurance framework (see e.g. Quadrini and Rios-Rull (2015) and Krueger *et al.* (2016) for reviews). Instead, here we analyse a different form of financial market imperfection, related to rent seeking and arising from weak institutions, and investigate its potential insurance and distorting implications which relate to wealth inequality. Notice however that although here we examine whether financial rent seeking is a mechanism which amplifies the effect of earnings inequality on wealth inequality, and we do find that there is a positive relationship between rent seeking and wealth inequality, we do not propose that it is rent seeking that explains the levels of wealth inequality that we observe in the data. Our findings suggest a moderate increase in overall wealth inequality for plausible changes in institutional quality.

3 Heterogeneous agents and rent seeking

We extend the model in Aiyagari (1994) to allow for rent seeking from the financial intermediation sector that requires the services provided by the lobbying sector. We analyse the long-run stationary equilibrium of an economy that is populated by a continuum of infinitely lived households distributed on the interval $I = [0, 1]$. In a stationary equilibrium, aggregate quantities are constant. Time is discrete and denoted by $t = 0, 1, 2, ...$ Households have identical preferences and derive utility from consuming one good. Labour supply is exogenous, but each household is subject to idiosyncratic labour productivity shocks. There are incomplete financial markets, and in particular, a single asset in the economy, so that households cannot fully insure against these idiosyncratic shocks. We assume that the institutional framework allows for a share of accumulated savings to be diverted away to rent-seeking households as opposed to output producing firms, via an intermediation (lobbying) activity, as modeled in the simple model above. That is, households compete with each other for a share of this pie and the quantity of resources that can be extracted is proportional to a household's wealth. Also, again as in the simple model above, the economy includes a producing sector, a financial sector which channels savings from households to firms, and a lobbying sector that the households use to extract assets from the financial sector. Each of these three sectors is represented by respective competitive firms.

3.1 Households

We present the problem for a "typical" household. The labour productivity of a typical household at time t is denoted by s_t. The household observes its labour productivity shock at the beginning of period t. We impose standard assumptions on the stochastic process $(s_t)_{t=0}^{\infty}$ (see also e.g. Acikgoz (2018) and Angelopoulos *et al.* (2019)). In particular, we assume that it evolves according to the m-state Markov chain with $m \times m$ transition matrix $Q_{ss'} = \Pr(s_{t+1} = s' | s_t = s)$, and state-space $S = [\overline{s}_1, \overline{s}_2, ..., \overline{s}_m]$, $\overline{s}_1 > 0$, $\overline{s}_{j+1} > \overline{s}_j$, $j = 1, ..., m-1$, with the σ-algebra $\mathcal{S}$ that is the power set of S. The transition matrix $Q_{ss'}$ provides the conditional probability that the household will be in state s' in period $t+1$, given that it is in state s in period t. Denoting by π_{ij} the elements of $Q_{ss'}$, we assume that there exists n_0 such that $(\pi_{ij})^n > 0$, $\forall (i,j)$, for all $n > n_0$, where $n \in \mathbb{N}_+$, and that $\pi_{11} > 0$. These assumptions guarantee that it has a unique invariant distribution (see e.g. Acikgoz (2018)). We denote the unique invariant distribution by ξ.

Each period, households receive labour income ws_t, where w is the wage rate, and interest income from accumulated assets ra_t, where r is the interest rate on assets, and assets are given by $a_t \geq -\psi$, with $-\psi \leq 0$ denoting an *ad hoc* borrowing limit. Define the set including the permissible values for a_t as $\mathcal{A} = [-\psi, +\infty)$. Moreover, there are additional returns that can be made in the asset/financial market by diverting resources from production and redirecting them back to the households, and higher wealth allows an individual to capture a higher share of these returns. In particular, there are assets which are circulated, via the financial market, between households, and are not used for productive purposes (e.g. returns from trading in the stock market, using financial instruments, or via transactions in estate that do not reflect an increase in production). These returns increase with relative wealth because wealthier households have more opportunity to exploit situations that create such returns.

We assume that while all households receive the common and guaranteed return r on their savings, implying asset income proportional to a fixed rate, there are *additional* returns via rent seeking that depend on the household's relative wealth. In particular, we assume that the institutional framework allows for a share θ of total assets, K, to be redistributed, via rent seeking competition, across households, where the parameter $\theta \geq 0$ quantifies the strength of institutions. The amount of this pie that a typical household can appropriate depends on its wealth relative to average wealth in the economy, $d_t \equiv \frac{a_t}{A}$,[6] subject to a price $p_\ell \in [0, 1]$ paid for the amount of assets extracted. The latter reflects the cost that the household incurs while rent-seeking (e.g. fees for lobbying, financial and legal advice). The assumption that rent extraction is determined by the individual's action relative that of its competitors, implying a positive relationship between extraction and own wealth, captures the idea that wealthier individuals can extract more resources. The amount that each household extracts in this specification is a smooth increasing function of its own wealth. We will examine, in a later section, the implications of an non-decreasing relationship $d(a_t)$ that requires a threshold level of wealth to enter into the rent seeking competition, making it thus even harder for less wealthy households to extract resources. Finally, households receive in the form of dividends (η) an equal share of any profits that the lobbying firm makes (this sector will be discussed later).[7]

Households use their income for consumption $c_t \geq 0$ and next-period wealth a_{t+1}. The aggregate quantities, w, r and p_ℓ, as well as η, A and K are assumed to be fixed, which is true if the household's actions take place in a stationary equilibrium, defined below. These quantities are taken as given by the household and are determined in equilibrium. Given their sources of income analysed above, households face the budget constraint:

$$c_t + a_{t+1} = (1 + r) a_t + w s_t + d_t \theta K - p_\ell d_t \theta K + \eta. \tag{1}$$

Define the net interest rate, $\widetilde{r}$, as

$$\widetilde{r} = r + (1 - p_\ell) \frac{\theta K}{A}, \tag{2}$$

[6] This (i.e. $\frac{a^i}{A}$) is consistent with Tullock's (1967) probabilistic contest-success function (see, among many others, Murphy *et al.* (1991) and Esteban and Ray (2011)).

[7] More generally, η can be taken to denote profits of all firms.

so that (1) can be written as:

$$c_t + a_{t+1} = (1 + \widetilde{r})\, a_t + ws_t + \eta. \tag{3}$$

Some points are worth making regarding the household's budget constraint. First, we do not explicitly allow the household to choose whether or how much to participate in rent seeking, i.e. what proportion of its assets to use to achieve higher returns. This is because, as long as $p_\ell \leq 1$, as we assume, the households will find it beneficial to participate in rent seeking with all their assets in this setup, if they were given such a choice. Rent seeking here reflects the existing institutional framework and captures additional returns (or costs) achieved by households with higher assets. Second, since households are allowed to borrow, (1)-(3) imply that there is a penalty imposed on households with negative wealth, in that they pay a higher cost for being in debt.[8] Third, returns to saving ($\widetilde{r}$) at the household level remain independent of the household's own wealth, and common across households. Therefore, the results of financial rent seeking on the wealth distribution are not driven by heterogeneity in returns to wealth or by assuming increasing returns to savings (see e.g. Fagereng *et al.* (2016), Benhabib and Bisin (2017) and Benhabib *et al.* (2018) on the importance of these factors). Finally, since p_ℓ is determined in equilibrium, its main role is to capture the general equilibrium costs of rent seeking, which the typical household cannot internalise (see also Besley and Ghatak (2010) for different ways to model the resource misallocation costs resulting from weak institutions).

The interest rate and wage rate are taken as given and satisfy $\widetilde{r} > -1$ and $w > 0$. Moreover, as has been shown (see e.g. Aiyagari (1994), Miao (2014, ch. 8) and Acikgoz (2018)), a necessary condition for an equilibrium with finite assets at the household level in this class of models is that $\beta\,(1 + \widetilde{r}) < 1$. Moreover, we require that $-\widetilde{r}\psi + w\overline{s}_1 + \eta > 0$, i.e. if the household is at the borrowing limit and receives the worst case labour income shock, it can have non-negative consumption, by borrowing the maximum possible again.

Households have inter-temporal discount factor $\beta \in (0, 1)$ and use a per period utility function $u(c_t) : [0, +\infty) \rightarrow \mathbb{R}$, which is bounded, twice continuously differentiable, strictly increasing and strictly concave. Furthermore, it satisfies the conditions $\lim\limits_{c\rightarrow 0} u_c(c) = +\infty$, $\lim\limits_{c\rightarrow\infty} u_c(c) = 0$ and $\lim\limits_{c\rightarrow\infty} \inf -\frac{u_{cc}(c)}{u_c(c)} = 0$. These assumptions are common in the literature relating to incomplete markets with heterogeneous agents in general equilibrium (see e.g. Aiyagari (1994) and Acikgoz (2018)).

[8] The main results below do not depend on imposing a zero borrowing limit. We allow for $\psi \geq 0$ because allowing for borrowing helps the model to match the realistic aspect of the wealth distribution relating to the percentage of households in debt.

Given values of $(w, \widetilde{r})$, and given initial values $(a_0, s_0) \in \mathcal{A} \times S$, the typical household chooses plans $(c_t)_{t=0}^{\infty}$ and $(a_{t+1})_{t=0}^{\infty}$ that solve the problem:

$$V(a_0, s_0) = \sup_{(c_t, a_{t+1})_{t=0}^{\infty}} E_0 \sum_{t=0}^{\infty} \beta^t u(c_t), \tag{4}$$

where $\beta \in (0,1)$, $a_t \in \mathcal{A}$, $c_t \geq 0$ is given by (3), and $u(c_t)$ and s_t satisfy the assumptions imposed earlier. To obtain the dynamic programming formulation of the household's problem, let $v(a_t, s_t; w, \widetilde{r}, \eta)$ denote the optimal value of the objective function starting from asset-productivity state (a_t, s_t). Suppressing dependence on aggregate quantities, the Bellman equation is:

$$v(a_t, s_t) = \\ = \max_{\substack{a_{t+1} \geq -\psi \\ c_t \geq 0}} \{u(c_t) + \beta \textstyle\sum_{s_{t+1}^h \in S^h} v(a_{t+1}, s_{t+1}) Q_{s_t, s_{t+1}}\}. \tag{5}$$

Standard dynamic programming results imply that the policy functions $a_{t+1} = g(a_t, s_t)$ and $c_t = q(a_t, s_t)$, which generate the optimal sequences $\left(a_{t+1}^*\right)_{t=0}^{\infty}$ and $(c_t^*)_{t=0}^{\infty}$ that solve (4), exist, are unique and continuous. Following e.g. Stokey *et al.* (1989, ch. 9), we define $\Lambda[(a,s), A \times B] : (\mathcal{A} \times S) \times (\mathcal{B}(\mathcal{A}) \times \mathcal{S}) \to [0,1]$, for all $(a,s) \in \mathcal{A} \times S$, $A \times B \in \mathcal{B}(\mathcal{A}) \times \mathcal{S}$, to be the transition function on $(\mathcal{A} \times S)$, induced by the Markov process $(s_t)_{t=0}^{\infty}$ and the optimal policy $g(a_t, s_t)$. This transition function is given by:

$$\Lambda[(a,s), A \times B] = \begin{Bmatrix} Q(s,B), \text{ if } g(a,s) \in A \\ 0, \text{ if } g(a,s) \notin A \end{Bmatrix}. \tag{6}$$

The analysis in Acikgoz (2018) implies the following results: (i) the Markov process on the joint state-space $(\mathcal{A} \times S)$ with transition matrix Λ has a unique invariant distribution denoted by $\lambda(A \times B)$; (ii) assets for the typical household tend to infinity when $\beta(1+\widetilde{r}) \to 1$; (iii) the expected value of assets using the invariant distribution is continuous in the net interest rate, $\widetilde{r}$.

3.2 Financial sector

This is modeled as in the simple model above. A single firm represents the financial sector. It borrows all available assets from households at the rate r and lends a proportion of these assets to the producing firms at the competitive interest rate r^f. In particular, it can only lend $(1-\theta) K$ assets to the producing firms because θK are diverted to other uses. This can capture for example intervention in the financial market (e.g. directed loans or subsidies to specific industries or households), or bonuses, payments and other expenses paid out to managers, shareholders or other individuals. The firm makes zero profits, requiring that:

$$\begin{aligned}(1+r)K &= (1+r^f)(1-\theta)K, \text{ or} \\ r &= (1+r^f)(1-\theta) - 1 \end{aligned} \tag{7}$$

3.3 Production sector

This is modeled similarly to the simple model above except that now the production technology is not linear. A single producing firm borrows assets from the financial sector at a constant rate r^f. Moreover, it operates an aggregate, constant returns to scale production function using as inputs the average (per capita) levels of capital K^f and employment L. The production function is given by $F(K^f, L^f)$ and is assumed to satisfy the usual Inada conditions. In particular, F is continuously differentiable in the interior of its domain, strictly increasing, strictly concave and satisfies: $F(0, L^f) = 0$, $F_{KL} > 0$, $\lim_{K\to 0} F_K(K^f, L^f) \to +\infty$ and $\lim_{K\to\infty} F_K(K^f, L^f) \to 0$. The capital stock depreciates at a constant rate $\delta \in (0,1)$. The firm takes the interest and wage rate as given and chooses capital and employment to maximise profits. Optimisation gives the standard first order conditions, where factor input prices are equal to the relevant marginal products:

$$w = \partial F(K^f, L^f)/\partial L^f, \tag{8}$$

$$r^f = \partial F(K^f, L^f)/\partial K^f - \delta. \tag{9}$$

3.4 Intermediation (lobbying) sector

Again this is modeled similarly to the simple model above except that now the technology is not linear. A single firm uses labour input L^ℓ (legal and financial advice and other lobbying services), which is paid the competitive wage w, to produce rent seeking, i.e. the quantity of assets extracted from the financial sector, using the production function:

$$\theta K = h\left(L^\ell\right), \tag{10}$$

where $h\left(L^\ell\right)$ is assumed to be increasing and concave and satisfies: $h(0) = 0$, $\lim_{L^\ell\to 0} h_{L^\ell}(L^\ell) \to +\infty$ and $\lim_{L^\ell\to\infty} F_{L^\ell}(L^\ell) \to 0$. The output of the lobbying sector (i.e. assets extracted from the financial sector) are then sold to households at the price p_ℓ, determining profits:

$$\eta^\ell = p_\ell h\left(L^\ell\right) - wL^\ell. \tag{11}$$

The first-order condition for maximum profits requires that:

$$p_\ell = \frac{w}{h_{L^\ell}(L^\ell)}. \tag{12}$$

Despite perfect competition, if $h\left(L^\ell\right)$ is characterised by decreasing returns to scale, profits are positive, and these determine $\eta > 0$ in the household's problem. However, if $h\left(L^\ell\right)$ is constant returns to scale, there are zero profits in equilibrium as it was the case in the simple model in section 2. Note that, given the inelastic demand for rent seeking services from the household problem, the amount of labour used in rent seeking, L^ℓ, is determined in equilibrium by (10). In turn, (12) determines the equilibrium price of rent seeking services.

3.5 General equilibrium

In this setup, a *Stationary Recursive Equilibrium* (SRE) is a set of positive real numbers $K, w\left(K\right), r\left(K\right), L^\ell\left(K\right), p_\ell\left(K\right), \eta\left(K\right)$, policy functions $a_{t+1} = g\left(a_t, s_t\right)$ and $c_t = q\left(a_t, s_t\right)$, and an aggregate stationary distribution $\lambda\left(A \times B\right)$, such that (i) the production and lobbying sector maximise profits, requiring that the conditions (8) - (12) are met; (ii) the financial sector has zero profits, so that (7) is satisfied; (iii) the policy functions for saving and consumption solve the household's optimum problem in (5); (iv) the cross-sectional distribution is given by the invariant distribution of households over the joint state space of asset holdings and labour productivity shocks, and (v) markets clear, implying that

$$\begin{array}{l} K^f = \left(1-\theta\right)K \\ L^f + L^\ell = \sum_{j\in S}\overline{s}_j\xi\left(\overline{s}_j\right) \equiv 1 \end{array}, \tag{13}$$

where

$$K \equiv \int_{\mathcal{A}\times S} g\left(a, s\right)\lambda\left(da, ds\right).$$

Aggregation over households can be obtained by using the methods discussed e.g. in Acemoglu and Jensen (2015). These imply that idiosyncratic uncertainty is cancelled out at the aggregate level so that aggregate outcomes are fixed quantities. Moreover, the invariant distribution at the household level also gives the cross-sectional distribution. Following standard arguments (commonly used in this class of models since Aiyagari (1994)), continuity of the asset supply and demand functions at the aggregate level with respect to the interest rate as well as the limit properties of supply and demand for assets, imply that a general equilibrium exists. A more general proof of existence of equilibrium for this class of models can be found in Acemoglu and Jensen (2015).

4 Calibration and computation

We calibrate the model using commonly used parameter estimates or information from US data, at an annual frequency. The majority of parameters in the model presented in Section 3 are the same as in standard versions of the Aiyagari (1994) model which have been calibrated to US data in the literature. Hence, we follow the existing research regarding the choice of these parameters.

We start with the earnings process for s_t. We assume that labour income follows an AR(1) process and following Kitao (2008), we set the autocorrelation coefficient equal to $\rho = 0.94$ and conditional variance equal to $\sigma^2 = 0.02$. These parameter values are informed by econometric estimation based on data from the Panel Study of Income Dynamics (PSID) (e.g. Storesletten *et al.* (2004) and Hubbard *et al.* (1994). We then approximate this AR(1) process with a 9-state Markov chain using the method in Rouwenhorst (1995). This determines an equally spaced state-space S, normalised to have a unit mean, and the 9×9 transition matrix $Q_{ss'}$.

The key parameter measuring the strength of the quality of institutions, θ, is the one that we vary below in our experiments to examine the effect of weaker institutions on the aggregate economy, wealth inequality and conditional welfare across the population. We discuss results of the model for a range of θ between 0 (implying that the model collapses to the standard Aiyagari (1994) model) and 0.02, (implying that the amount of assets that are extracted equals 5% of output), but we set $\theta = 0.01$ for our benchmark calibration, which implies that: (i) 3.5% of the labour force work in the intermediation - lobbying sector. Approximating jobs related to financial rent seeking, L^{ℓ}, by a subset of occupations in the financial and law firms (see e.g. Murphy *et al.* (1991) for approximating rent seeking with labour force expertise in law), then this number is consistent with 57% percent of the labour force working in "Legal occupations" and "Business and financial operations" (Bureau of Labour Statistics, Labor Force Statistics from the Current Population Survey); (ii) the model predicted resources that are extracted due to financial rent seeking, as a share of consumption is $\frac{\theta K}{C} = 3.6\%$, which is less than the estimate of 12.5% in Lopez and Pagoulatos (1994) for the welfare loss of domestic consumption for the US due to rent seeking related to trading barriers; and (iii) the spread $r^f - r$ is 0.01. The average spread between the return to capital and the safe real short rate in the US is around 3% before the 2007-2008 financial crisis and almost double after it (see Hall (2013)). This spread captures the level of financial frictions (Hall (2013)), and in effect, in our model, rent seeking is a form of financial friction (see also e.g. Khwaja and Mian (2011)). Hence, our model predicts a spread that is caused by the specific financial friction that we model that is sizeable, yet significantly lower than the spread observed in the data as a result of all financial frictions.

The preferences of the household and production technology follow standard calibrations for the US since Aiyagari (1994). In particular, we use a CRRA utility function:

$$u(c) = \frac{c^{1-\sigma}}{1-\sigma}, \tag{14}$$

and set $\sigma = 2$. Furthermore, by defining as our benchmark calibration the case when $\theta = 0.01$, we calibrate β and ψ to match targets for the US economy. Specifically, we calibrate $\beta = 0.967$ so that the economy attains a ratio of $\frac{K}{Y} = 2.65$ (see e.g. Kitao (2008) or Quadrini (2000)). The borrowing limit is set to $\psi = 0.15$, so that the model predicts that, in equilibrium, the percentage of indebted households (i.e. those with negative net-worth) is about 16% when $\theta = 0.01$.[9] The implied borrowing limit means that households can borrow up to the 15% of mean annual household income in the steady state. Moreover, we set the annual depreciation rate to be $\delta = 0.10$ and we use a Cobb-Douglas production function with constant returns to scale with respect to its inputs:

$$Y = A \left(K^f\right)^{\alpha} \left(L^f\right)^{1-\alpha}.$$

We normalise $A = 1$ and set α to one third (see, e.g. Heathcote *et al.* (2010)). The above parameters which are kept constant across model variants and calibrations examined in the following sections are summarised in Table 1.

[9] This number is consistent with Kuhn and Rios-Rull (2016)). Moreover, it is also consistent with Wolff (2000) in which the percentage of agents with zero or negative wealth was 15.5% in 1983, and 18% in 1998 (see Table 1 in Wolff, 2000).

Table 1: Model Parameters

β	σ	ψ	δ	A	α	ρ	σ^2	θ	Z
0.967	2.0	0.15	0.10	1.00	0.33	0.94	0.02	0.01	1.2

Finally, regarding the lobbying production function, $h\left(L^{\ell}\right)$, we consider a constant returns to scale technology (implying $\eta = 0$ in equilibrium) i.e.

$$h\left(L^{\ell}\right) = ZL^{\ell}, \tag{15}$$

Under (15), we calibrate the parameter Z, which measures the productivity of labour resources in the lobbying sector so that, at the maximum $\theta = 0.02$ considered, the share of the labour force working for the lobbying sector is up to $6-7\%$ in the various experiments considered, while it is about $3-4\%$ for the more moderate $\theta = 0.01$.

To solve the model computationally to obtain the stationary equilibrium, we use an iterative algorithm. We first guess a value for $K = K_j$, calculate $r(K_j)$, $r^f(K_j)$, $w(K_j)$, $p_\ell(K)$, $L^\ell(K)$ and $\eta(K)$ and solve the problem of the "typical" household by value function iteration with interpolation. We discretise assets in the grid $[-0.15, 50]$ and with 500 points and a denser grid (5000 points) for the choice set of assets.[10] Then, given the policy function of the household, $g(a_t, s_t)$ and the law of motion of the exogenous process, s_t, we can construct the transition function Λ_{K_j} and calculate the stationary distribution λ. Because $g(a_t, s_t)$ does not have to be on the asset grid, we use the "histogram" method to compute λ (e.g. Young (2010) and Heer and Maussner (2009)). We then compute the average value of capital K_j^* using λ, check whether $\left|K_j^* - K_j\right| < 10^{-4}$, update the guess if this not true and repeat until convergence.

To obtain the dynamic paths under perfect foresight, we work as follows. In period zero, the economy is in the stationary equilibrium with $\theta = 0.01$. At this point, a change in the future path of θ is made known, which is common knowledge and deterministic. After τ years of transition period, the economy will converge to the new stationary equilibrium. For example, over the following 30 years, the quality of institutions deteriorates smoothly so that in 30 years time it is twice as bad ($\theta = 0.02$); or, a reform is in place such that the quality improves smoothly so that in 30 years time there is no extraction possible ($\theta = 0$). To solve for the transition path, we follow

[10] There is a near-zero probability of hitting the upper bound on assets (less than $1*10^{-5}$ for the benchmark calibration.).

the literature and use a shooting-algorithm to iterate on the path of prices and to update the path of prices using a constant weight (see e.g. Huggett (1997) and Boppart *et al.* (2018)). The idea is to guess on the path of prices, solve the household problem using backward induction (having solved first for the new final stationary equilibrium), construct a sequence of transition functions and of aggregate quantities, check whether these match the guessed sequence, and update if necessary.[11]

5 Wealth inequality and rent seeking

We examine the effect of increases in financial rent seeking on wealth inequality.

5.1 Rent seeking increases wealth inequality...

In Table 2, we summarise the key predictions of the model regarding the wealth distribution and key aggregate quantities for three different stationary equilibria, corresponding to three values of θ. The main result from Table 2 is that wealth inequality is higher when institutional quality is lower, implying higher rent seeking. We can consider as a proxy for rent seeking activity the proportion of labour force working in the lobbying sector ($L^\ell = 1 - L^f$), or assets extracted as a share of output ($\frac{\theta K}{Y}$). Both measures increase monotonically with θ.

As θ increases, so do two typical measures of wealth inequality, namely, the gini index of wealth inequality and the coefficient of variation (denoted as CV in the tables) defined as the ratio of the standard deviation of the wealth distribution over its mean. We further investigate the wealth distribution and find that for the first three quintiles, the proportion of wealth owned decreases as θ increases, whereas for the upper two quintiles, the proportions increase. This is summarised in Table 2 by the evolution of the percentage of total wealth owned by the lower 60% (denoted as Low 60%) and the percentage owned by the upper 40% (denoted as Top 40%). Hence, the increase in wealth inequality, following the increase in θ, reflects changes across the distribution and is not limited to the tails.[12]

[11] To solve for the dynamic paths and obtain conditional welfare for each model solution presented below, requires approximately 2 hours on a cluster computer, using parallel processing (16 cores) with Matlab2018a.

[12] Similar qualitative results regarding the effect of increases in θ are obtained in a calibration of the model that does not allow for debt. In this case, since the wealth distribution is artificially truncated, overall wealth inequality is lower, but the main results in Table 2 are not affected.

Table 2: Wealth distributions and equilibrium for different θ (base)

	$\theta = 0$	$\theta = 0.01$	$\theta = 0.02$
Gini	0.608	0.620	0.63
CV	1.240	1.274	1.305
Low 60%	0.152	0.139	0.132
Top 40%	0.848	0.861	0.868
K	4.7	4.145	3.714
K/Y	2.806	2.65	2.519
$\frac{\theta K}{Y}$	-	0.027	0.050
L^f	-	0.965	0.938
p_ℓ	0.931	0.900	0.873
r	0.019	0.017	0.014
$\widetilde{r}$	0.019	0.018	0.017
r^f	0.019	0.027	0.035
w	1.117	1.080	1.048
% indebted	0.145	0.159	0.172
Welfare	0.057	0.014	-0.025

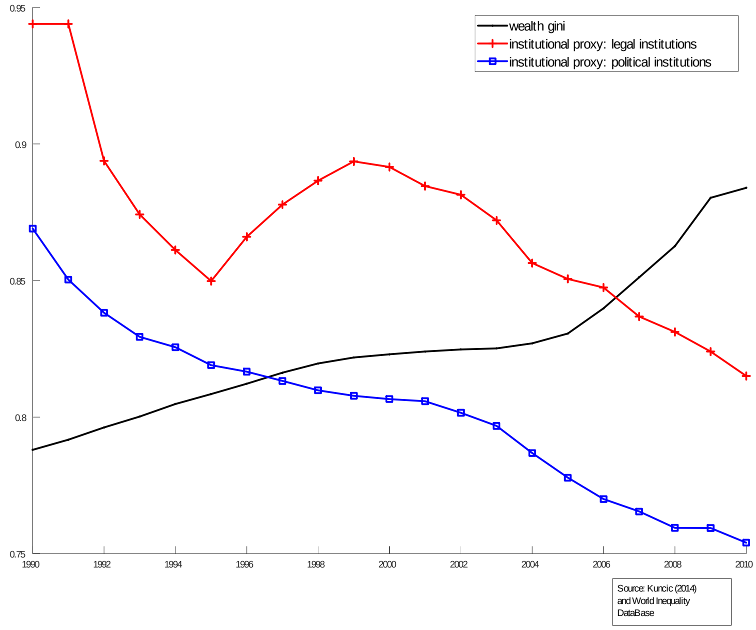
We also summarise in Table 2 some useful general equilibrium quantities. In particular, we see that increases in θ lead to reductions in aggregate capital, the market and the effective rate of return to investment (r and $\widetilde{r}$, respectively), the return to labor (w) and thus in average labour income. Moreover, rent seeking reduces the welfare of a typical household populating the economy in a stationary equilibrium. The latter is calculated as the expected utility of a typical household in the stationary equilibrium using (14). Therefore, the results in Table 2 demonstrate that weaker institutions, which allow for a higher share of assets to be extracted during financial transactions, worsen the overall incentives to accumulate assets, reduce labour income, and lead to a reduction in aggregate welfare in a stationary equilibrium.[13]

We next examine the dynamic effect of a worsening, or an improvement, of the quality of institutions on aggregate quantities and the gini measure of wealth inequality. To contextualise these paths, we plot in Figure 1 the times series of proxies of the quality of institutions and the gini measure of wealth inequality. As can be seen, since 1990, proxies of the quality of institutions show a deterioration, while wealth inequality has increased.[14]

[13]Similar qualitative effects to Table 2 are obtained if instead of linear lobbying techology, we assume a Cobb-Douglas technology with decreasing returns to labour input.

[14]The institutional proxies in Figure 1 are from Kuncic (2014), who constructs indices on

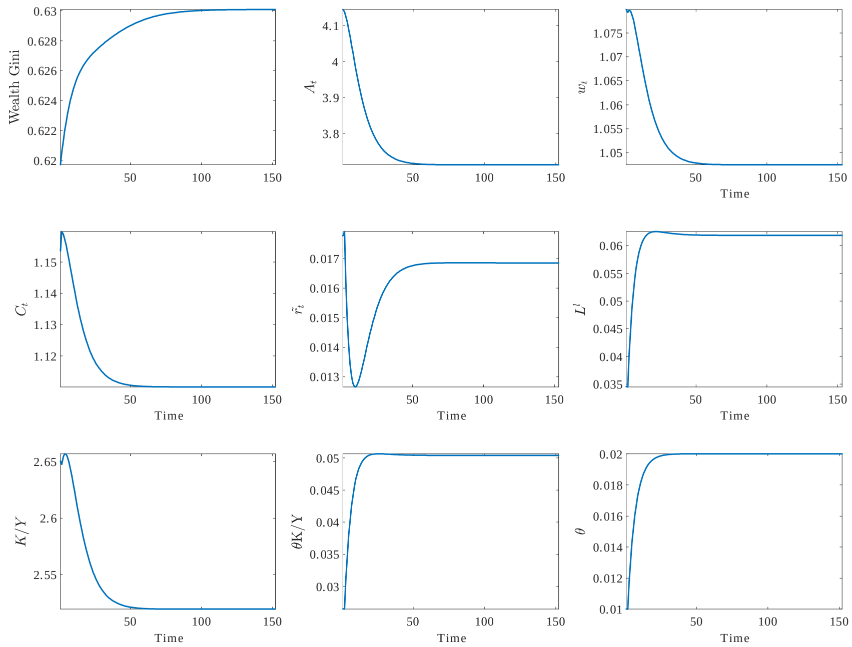
Figure 1: Quality of intitutions versus wealth inequality, USA



In Figure 2, we plot the general equilibrium paths under a deterioration of institutions. In particular, we assume that the economy is in the stationary equilibrium summarised under $\theta = 0.01$ in Table 2, and at time zero it becomes known to all households that over the following 30 years, the quality of institutions will deteriorate smoothly so that in 30 years time $\theta = 0.02$. In other words, the time path for θ shown in Figure 2 becomes common knowledge. We solve then the transition of the economy to this new stationary equilibrium. As can be seen, rent seeking increases over time, and with it, there is a reduction in aggregate quantities and an increase in wealth inequality, consistent with the empirical observation in Figure 1. Note that the dynamic paths of the quantities shown in Figure 2 are consistent with the results in Table 2. In Figure 3, we show the transition of the economy, from the stationary equilibrium summarised under $\theta = 0.01$, to a new stationary equilibrium with $\theta = 0$, working as above. We find that the dynamic paths are opposite to those under the institutional deterioration.

legal, political and economic institutional quality. The wealth inequality data are from the World Inequality Database. In Figure 1, we show the time series for the USA, consistent with our model calibration. However, negative correlations between the wealth gini and both the political and legal institutional quality proxies are obtained for the other three countries for which the relevant data is available, namely China (-0.47, -0.23), France (-0.7, -0.47) and Russia (-0.7, -0.6).

Figure 2: General equilibrium dynamics, from θ=0.01 to θ=0.02

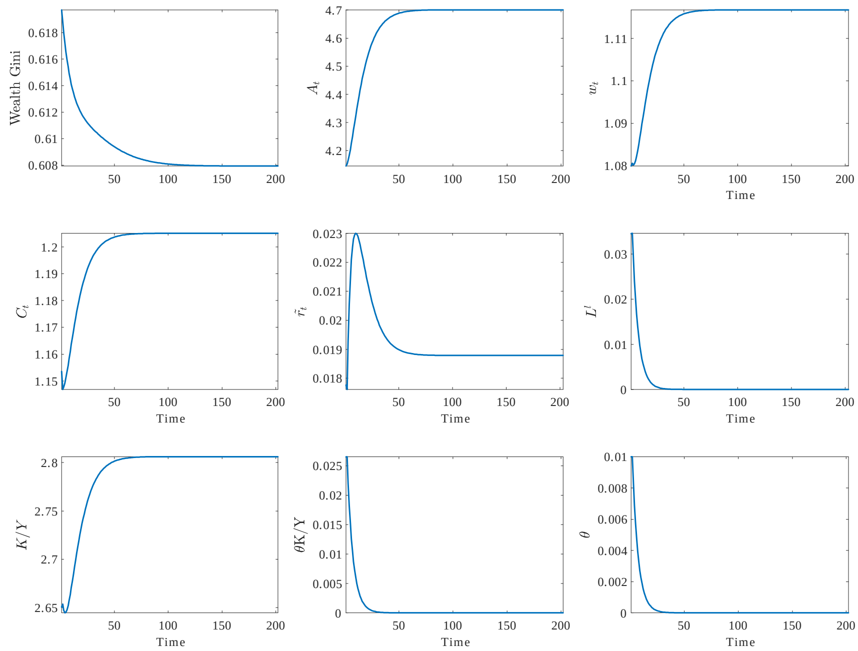


5.2 ...because of distortions at the aggregate level

The results demonstrate that a worsening in institutional quality, implying increased rent seeking, has adverse effects on both aggregate quantities and inequality. As the results in the next table will show, the deterioration of the wealth distribution follows from the deterioration of aggregate outcomes. In particular, we consider a partial equilibrium version of the model, where prices are kept fixed, and we examine the effects of changing θ on aggregate savings and wealth inequality. We set the prices to reflect the cost of lobbying activities where the price of rent seeking is determined by market interactions and the services provided by the lobbying sector. In particular, we set $p_\ell = 0.900$, $w = 1.080$ and $r = 0.0168$, which are the equilibrium prices when $\theta = 0.01$ in Table 2. The effects of decreasing or increasing θ in this framework on the wealth distribution and the welfare of the typical household are shown in Table 3 below for the stationary equilibrium, and in Figure 4 for the transition dynamics under perfect foresight. As can be seen, now increases (decreases) in the amount of assets that can be extracted decreases (increases) inequality.

In this model, wealth inequality is the result of the exogenous part of inequality in the idiosyncratic component of earnings under incomplete insurance, and of the propagation mechanism of asset accumulation, which is an endogenous decision of the agents in the economy. Asset accumulation,

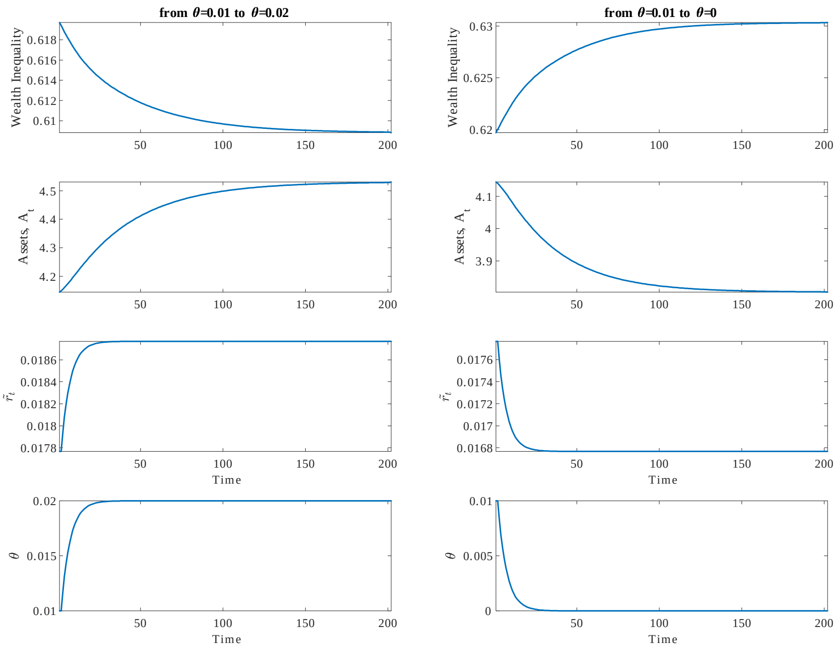
Figure 3: General equilibrium dynamics, from θ=0.01 to θ=0



in turn, is determined by returns to saving and disposable income. Returns to saving, as can be seen by (2), are determined both by the market interest rate and the returns that can be achieved by rent seeking.

In partial equilibrium, where the market return (r) and the cost of rent seeking (p_ℓ) are fixed, an increase in θ (implying an increase in rent seeking activities, measured by $\frac{\theta K}{Y}$) increases the effective or net return to savings ($\widetilde{r}$), setting in motion a mechanism which leads to a rise in asset accumulation and a reduction in wealth inequality. In particular, there are no negative implications from rent seeking on the market interest rate (r) or cost of rent seeking (p_ℓ) that the household faces. Moreover, there are no negative effects on the labour income of the households, because the wage rate (w) is held fixed. As a result, the typical household interprets the opportunity of rent seeking as an increase in the effective return to saving ($\widetilde{r}$), which is a result of the assumption that extraction is a positive function of private assets (wealthy individuals can extract more). Hence, households increase their savings, which in turn implies that they are less exposed to earnings shocks. Therefore, idiosyncratic earnings shocks do not lead to as big a spread of disposable income across households, and thus to as big a spread in investment decisions, leading to lower wealth inequality for the same earnings distribution. Rent seeking thus provides a means for self-insurance which

Figure 4: Partial equilibrium dynamics



works to reduce the inequality effects of idiosyncratic earnings.

Table 3: Wealth distributions in partial equilibrium for different θ.

	$\theta = 0$	$\theta = 0.01$	$\theta = 0.02$
Gini	0.630	0.620	0.609
CV	1.306	1.274	1.242
Low 60%	0.134	0.139	0.148
Top 40%	0.866	0.861	0.852
K	3.804	4.145	4.531
p_ℓ	0.900	0.900	0.900
r	0.017	0.017	0.017
$\widetilde{r}$	0.017	0.018	0.019
r^f	-	-	-
w	1.080	1.080	1.080
% indebted	0.172	0.159	0.147
Welfare	0.005	0.014	0.024

However, when the general equilibrium was analysed in Table 2, the results were different. In this case, the resource extraction and misallocation associated with rent seeking was also considered and worked to reduce savings in the following way. First, the amount of aggregate savings extracted implied a financial loss for the financial sector and thus reduced the market return (r) directly, as can be seen in equation (7). This fall, in turn, reduced the effective return ($\widetilde{r}$), because the reduction in (r) outweighed the additional returns from rent seeking. The reduction in $\widetilde{r}$ implied a reduction in households' incentives to save.[15] Second, the reduction in the amount of capital used for production (because a proportion θ is extracted) also implied a reduction in the wage rate (w), and thus in mean earnings. Given that savings are a positive function of earnings in this class of models (see e.g. Aiyagari (1994)), this also worked to reduce savings. Both effects implied a reduction in mean asset holdings per household, in turn implying that households were more exposed to idiosyncratic earnings shocks so that the same earnings risk implied higher wealth inequality.

In Appendix A, we present a simple model that demonstrates the importance of the distortions implied by rent seeking at the general equilibrium level as a driver of inequality, in a setup where inequality decreases when institutional quality deteriorates in partial equilibrium. That model incorporates many simplifying assumptions, thus not allowing the quantitative analysis of wealth inequality under stochastic productivity, but demonstrates analytically, in an example economy, the importance of the misallocation of resources as a driver of wealth inequality.

Therefore, the proposition that the reason that inequality increases under rent seeking is that it is the wealthier individuals/agents who extract the more from the economy's wealth is not confirmed here. Instead, as our results from the previous section (Table 2) indicate, inequality increases under rent seeking because rent seeking has a negative impact on aggregate quantities. Overall, there are two effects from rent seeking. The first works at the individual level and tends to decrease inequality because it is the wealthier who extract more, which increases the incentives to accumulate wealth and mutes the importance of exogenous factors of idiosyncratic effects that create inequality. The second works via general equilibrium, and tends to increase wealth inequality because rent seeking leads to a reduction in the effective return to saving and the disposable income and thus works in the opposite

[15] It should also be noted that there are additional, second-order effects on the interest rate in general equilibrium. First, because there are fewer resources available to firms (because of extraction), the marginal product of capital increases, hence r^f and thus r also tend to increase. Second, because of allocation of labour to the lobbying sector, the labour input used in production is reduced, and thus the marginal product of capital is reduced, hence reducing r^f, and thus r. Third, increased demand for rent seeking services affects the price p_ℓ and thus $\widetilde{r}$. The net outcome of all these effects is a reduction in effective returns, $\widetilde{r}$, as captured in Table 2.

direction. In the calibrated model economy, the second effect dominates so that rent seeking leads to a worsening of aggregate outcomes and inequality. Thus, that the wealthier extract more, other things equal, tends to decrease wealth inequality in this framework. It is only because of the worsening of the aggregate economy that rent seeking increases wealth inequality.

6 The distribution of welfare gains/losses

We examine who gains/loses more from financial rent seeking. To do so, we calculate the conditional welfare change, for all households on the cross-sectional distribution associated with the stationary economy for $\theta = 0.01$, resulting from the transition that follows the deterioration in the quality of institutions in Figure 2. In particular, we define as

$$V^{*}(a,s) = E_0 \sum_{t=0}^{\infty} \beta^t u(c^{*}(a_t, s_t) \mid a_0 = a, s_0 = s),$$

the expected lifetime utility associated with $c^{*}(a_t, s_t)$, the decision rule under the stationary equilibrium for $\theta = 0.01$, and as

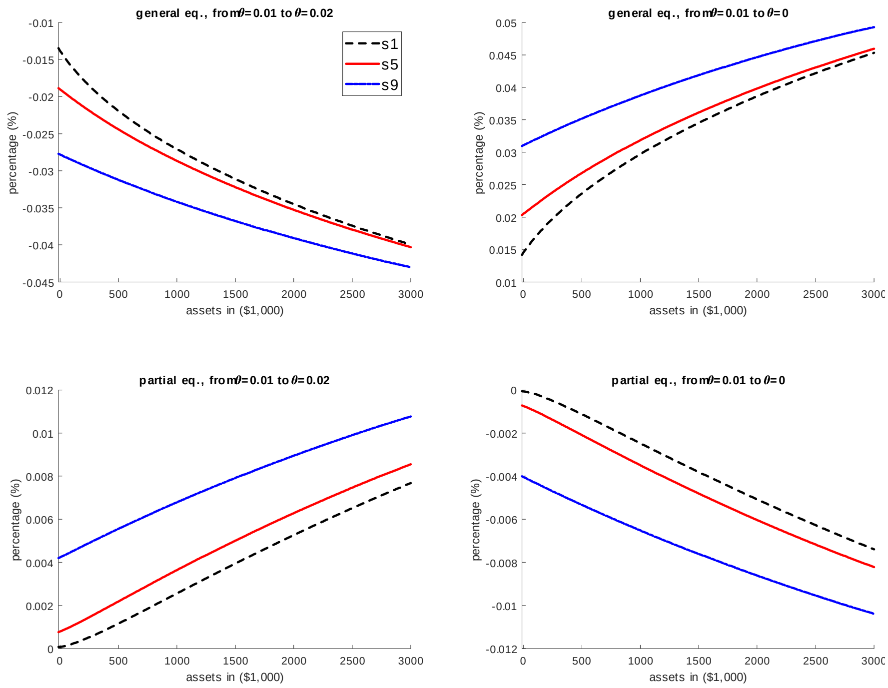
$$V'(a,s) = E_0 \sum_{t=0}^{\infty} \beta^t u(c'_t(a_t, s_t) \mid a_0 = a, s_0 = s),$$

the expected lifetime utility associated with $c'_t(a_t, s_t)$, the sequence of decision rules along the transition path following the dynamics for θ in Figure 2. We then define the consumption equivalent variation, conditional on initial assets and earnings, $\upsilon(a,s)$, as the percentage change in consumption required to be given to the household under the stationary equilibrium for $\theta = 0.01$, so that it is indifferent between remaining in this economy as opposed to the economy that follows the transition paths in Figure 2. In particular, $\upsilon(a,s)$ is defined as the quantity that solves

$$E_0 \sum_{t=0}^{\infty} \beta^t u((1+\upsilon(a,s))\, c^{*}(a_t, s_t)) = E_0 \sum_{t=0}^{\infty} \beta^t u(c^{*}(a_t, s_t)).$$

We plot the conditional consumption equivalent variation, across the distribution of initial level of assets, in subplot (1,1) of Figure 5. To facilitate presentation, we show this for three levels of earnings, the lowest, the median and the highest. Then, in subplot (1,2) we plot the conditional consumption equivalent variation computed following the improvement in institutional

Figure 5: Consumption equivalent variation



quality (i.e. for the dynamic paths in Figure 3). Finally, in subplots (2,1) and (2,2) we plot the conditional welfare change, in terms of consumption equivalent variation, following, respectively, the worsening and improvement of institutional quality in Figure 4, i.e. in partial equilibrium, for given prices.

The first main result in subplots (1,1) and (1,2) of Figure 5 is that an increase (decrease) in rent seeking implies welfare losses (gains) for all levels of initial wealth and earnings. The second main result is that these gains and losses are not distributed equally across the population. In particular, for any given level of initial earnings, welfare losses (gains) are higher for households with higher initial level of wealth; and, for any given initial level of wealth, welfare losses (gains) are higher for households with higher initial level of earnings.

To understand the importance of general equilibrium distortions for these results, we compare them to the welfare gains/losses across the initial distribution under partial equilibrium, in subplots (2,1) and (2,2) of Figure 5. As can be seen, the results are reversed. In particular, all households gain (lose) from a deterioration (improvement) in the quality of institutions that implies more (less) rent seeking, and the gains (losses) are higher for higher initial wealth and earnings. Therefore, partialing out the general equilibrium effects, financial rent seeking is beneficial to all, because it provides a means of insurance against earnings risk; and the gains are higher for the poorer households, who have lower ability for self insurance. However, when the distortions at the general equilibrium are also considered, the results are reversed. The disincentives to save (and thus to self-insure against idiosyncratic earnings risk), caused by the reduction in returns to savings due to financial rent seeking, are strong enough to overturn the direct insurance benefits of financial rent seeking. In other words, the general equilibrium reduction in self-insurance is more important, quantitatively, than the additional possibilities for insurance that financial rent seeking generates.

The wedge in the returns to savings, caused by financial rent seeking, works, in effect, as an implicit tax on savings. Viewed in this respect, its effect in terms of reducing welfare monotonically with initial wealth and earnings, is similar to the welfare reducing effect of capital income taxation (see e.g. Figure 6 in Kitao (2008)). However, capital income tax reforms can create winners and losers (e.g. Domeij and Heathcote (2004) and Kitao (2008)), whereas financial rent seeking reduces welfare for all, implying that an improvement in institutions is a Pareto improving policy.

7 Further analysis

We examine the robustness of the results to assuming that there is a minimum requirement to participate in financial rent seeking, and the importance of the productivity in the intermediation (lobbying) sector and of labour misallocation in determining the severity of the deterioration of institutions for wealth inequality.

7.1 Threshold effects

We examine the robustness of the above results to assuming that participation in the rent seeking contest requires a threshold level of assets. In particular, we assume that the relationship $d(a_t)$ is given by

$$d(a_t) = \left\{ \begin{array}{l} 0, \text{ if } a_t \leq a^m \\ \frac{a_t}{A}, \text{ if } a_t > a^m \end{array} \right\}, \tag{16}$$

where we consider different possibilities for a^m, and more specifically, that a^m equals mean assets over the cross-section of households, or half the quantity of mean assets, or twice the quantity of mean assets. We find that welfare losses always increase with initial wealth, as was also reported under under the base case in subplot (1,1) of Figure 5, essentially for the special case where

$a^m = -\phi$. There are, however, higher welfare losses across the distribution. The higher the threshold a^m, the more households are excluded from financial rent seeking, and thus, naturally, the higher wealth inequality under weak institutions is. We illustrate this point in Table 4 below, which re-produces the results in Table 2 using (16) for $d(a_t)$ in (1), for the case where a^m equals average assets.

Table 4: Wealth distributions and equilibrium for different θ (*threshold*)

	$\theta = 0$	$\theta = 0.01$	$\theta = 0.02$
Gini	0.609	0.625	0.643
CV	1.241	1.284	1.327
Low 60%	0.151	0.133	0.118
Top 40%	0.849	0.867	0.882
K	4.699	4.143	3.711
K/Y	2.805	2.650	2.518
$\frac{\theta K}{Y}$	-	0.026	0.050
L^f	-	0.965	0.938
p_ℓ	0.931	0.900	0.873
r	0.019	0.017	0.014
$\widetilde{r}$	0.019	0.018	0.017
r^f	0.019	0.027	0.035
w	1.117	1.080	1.047
% indebted	0.148	0.169	0.193
Welfare	0.057	0.013	-0.027

7.2 The importance of productivity in lobbying

The lobbying sector matters for the effect of rent seeking on wealth inequality. By competing for resources with the productive sector, a lobbying sector where labour has a higher productivity will increase returns for labour. Hence, in this case, an increase in labour productivity in lobbying will raise the wage rate, increasing labour income and thus having a positive effect on savings. To demonstrate this point quantitatively, we examine the impact of higher labour productivity in the lobbying technology, $\theta K = ZL^\ell$. In particular, we re-calculate the quantities in Table 2 by setting $Z = 1.6$ and summarise the results in Table 4. As can be seen in this Table, although the results are qualitatively similar with those in Table 2, the effects of a worsening of institutions associated with an increase in θ lead to a smaller increase in inequality and a lower reduction in aggregate capital and welfare.

Table 5: The importance of extraction technology ($Z = 1.6$)

	$\theta = 0$	$\theta = 0.01$	$\theta = 0.02$
Gini	0.608	0.618	0.626
CV	1.240	1.269	1.292
Low 60%	0.152	0.140	0.135
Top 40%	0.848	0.860	0.865
K	4.7	4.275	3.926
K/Y	2.806	2.691	2.591
$\frac{\theta K}{Y}$	-	0.027	0.052
L^f	-	0.973	0.951
p_ℓ	0.931	0.680	0.664
r	0.019	0.015	0.011
$\widetilde{r}$	0.019	0.018	0.017
r^f	0.019	0.025	0.031
w	1.117	1.088	1.062
% indebted	0.145	0.156	0.164
Welfare	0.057	0.024	-0.006

The higher labour productivity implies an increase in wages and a lower misallocation of labour to lobbying, accompanied by a lower cost of rent seeking at the individual level in terms of p_ℓ. This analysis suggests that the negative effects of financial rent seeking on wealth inequality and aggregate outcomes are worse when the lobbying sector is less productive other things equal. In this sense, conditional on the degree of extraction from aggregates wealth (i.e. θ in this model), a framework for lobbying intermediation that renders it more effective (i.e. that implies a higher Z in terms of the model) is more beneficial to inequality because a smaller amount of labor needs to be misallocated.

7.3 The importance of labour misallocation

The social cost associated with misallocation of resources in this model is due to two channels. First, it is caused by the direct reduction of capital available for production, since a proportion θ of total assets is not used for productive purposes. Second, it is caused by a share of labour diverted to work in the lobbying sector, to provide rent seeking services. To quantify the contribution of the latter, relative to the former, we consider a variation of the model where we assume that rent seeking services do not require intermediation of a labour employing sector, but they are instead merely assumed to reflect a fixed transaction cost, captured by an exogenously set p_ℓ. To this end, we set $p_\ell = 0.9$ and solve the base model again, without the lobbying sector, following for the remaining parameters the calibration giving the results in Table 2. We summarise the new results in Table 5.

Table 6: The importance of labour misallocation

	$\theta = 0$	$\theta = 0.01$	$\theta = 0.02$
Gini	0.608	0.617	0.625
CV	1.240	1.266	1.288
Low 60%	0.152	0.140	0.135
Top 40%	0.848	0.860	0.865
K	4.7	4.273	3.904
K/Y	2.806	2.642	2.496
$\frac{\theta K}{Y}$	-	0.026	0.05
L^f	-	1	1
p_ℓ	0.931	0.900	0.900
r	0.019	0.017	0.016
$\widetilde{r}$	0.019	0.018	0.018
r^f	0.019	0.027	0.036
w	1.117	1.078	1.043
% indebted	0.145	0.154	0.163
Welfare	0.057	0.016	-0.023

By comparing the results in Table 5 to those in Table 2, we can see that both capital and labour misallocation matter for the deterioration of aggregate outcomes and the increase in wealth inequality. In particular, the increase in wealth inequality and the reduction in welfare associated with an increase in θ are smaller compared with those in Table 2. Labour is not diverted away from production, which supports the productivity of capital (and thus r^f and in turn r and $\widetilde{r}$)[16], which increases asset accumulation relative to the results in Table 2, implying a lower relative increase in wealth inequality. Therefore, the increase in wealth inequality seen in Table 2 is driven by the reduction in both capital and labour inputs in production, as a result of rent seeking. This is similar to the misallocation of talent effect

[16] Due to rounding, under $\theta = 0.01$, the results appear the same in Tables 2 and 5, but interest rates in Table 5 are higher. This is more evident under $\theta = 0.02$.

in Murphy *et al.* (1991).

8 Conclusions

In this paper, we considered a version of the incomplete markets heterogeneous agent model in Aiyagari (1994) that allowed for a share of accumulated assets to be diverted away from productive uses to redistributive benefits to households via rent seeking competition which favoured the wealthy. In particular, we assumed that the amount of resources that can be extracted increases with relative wealth.

Rent seeking in this context works to create additional incentives for the household to increase its savings and thus to self-insure against idiosyncratic shocks for which there is no insurance market. As a result, conditional on aggregate quantities, financial rent seeking works to decrease wealth inequality, despite, or in fact because, it is the wealthier who extract more resources.

However, rent seeking also implies a misallocation of resources at the social or aggregate level, because rent seeking reduces directly the amount of savings that can be used for production, and indirectly the amount of labour that can be used for production. The latter happens because rent seeking requires intermediation in the form of lobbying services, and financial and legal advice, which absorb labour services from the producing sector (the talent misallocation effect in Murphy *et al.* (1991)). These effects tend to reduce market returns to savings and household income, and thus the incentive and ability of households to accumulate assets and self insure, amplifying the effect of idiosyncratic earnings shocks on wealth inequality.

When this general equilibrium model was calibrated to the U.S., we found that the resource misallocation effects at the aggregate level dominate. As a result, wealth inequality increases when institutions get weaker in the sense that financial rent seeking can divert a higher share of aggregate savings from production to a redistributive, contestable pie. Moreover, the wedge in returns to savings that financial rent seeking causes in general equilibrium creates disincentives to save and to self-insure against idiosyncratic earnings risk that are strong enough to overturn the direct insurance benefits of financial rent seeking, for all households. Therefore, reforms to improve the quality of institutions are Pareto improving. However, because the implicit value of the direct insurance benefits that rent seeking offers in partial equilibrium is higher for the poorer households, who are lacking in assets and thus in means of self insurance, the welfare gains from such reforms will be increasing in initial wealth.

Rent seeking can increase wealth inequality for additional reasons that we did not study here. These may include, for instance, stochastic returns to rent seeking, especially in relation to earnings risk, or if rent seeking requires a different type of asset, linking thus rent seeking to portfolio choices. More directly, there may be unequal opportunities for rent seeking, for example, certain groups may be permanently excluded from the rent seeking competition, in which case there is effectively a form of *ex ante* heterogeneity in rent seeking. Our analysis shows that even when these reasons are not present, and even when rent seeking provides an additional insurance mechanism to correct for financial market imperfections, the aggregate-level resource misallocation effects imply that financial rent seeking activities increase wealth inequality and reduce welfare for all households.

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9 Appendix: a simple model of inequality and rent seeking

We present a simple model with rent seeking and income inequality that can be solved analytically to demonstrate the importance of aggregate-level effects of rent seeking on inequality. Important simplifying assumptions (which are relaxed in the main model) include a two-period horizon, and linear utility and production functions. A linear utility function implies that incomplete financial markets do not lead to precautionary wealth accumulation under earnings risk and inequality, whereas a linear production function implies that the effect of resource misallocation, in the form of diversion of resources from production to lobbying and rent seeking, does not affect market returns. Both are, of course, important limitations, which are addressed in the analysis of the full model which is solved numerically in the main body of the paper.

We assume that there are two time-periods, $t = 1, 2$ and that the economy is populated by N households. Production takes place in the second period only. Weak institutions imply that households extract a share of aggregate savings from the financial sector and this share is proportional to their individual wealth relative to aggregate wealth (this popular modelling in the literature on rent-seeking goes back to Tullock's (1967) idea of a rent-seeking contest). To do so, they use the services of a lobbying sector subject to intermediation fees. Labour supply is exogenous, but each household's labour productivity and income differ and depend on stochastic productivity which for simplicity takes two values. There are N final good producing firms, N financial firms that channel savings/capital from households to the final good producing firm and N lobbying firms that provide lobbying services to households on how to extract assets from the financial sector. Firms are assumed to be competitive (making zero profits). The timing is as follows. Households make their consumption-saving decisions in the first period without knowing their productivity and hence their future wage earnings. Then, in the second period, productivity shocks are materialised, and firms make their own decisions under certainty.

We sketch the structure of the economy and the problems of the various economic agents briefly below, and refer the reader to Section 3 for a full analysis. Where possible, we will keep assumptions and notation the same between the simple model here and the general model in Section 3, so that the former will be a simplified representation of the latter that delivers the key ideas analytically, at the cost of missing out some important channels qualitatively and quantitatively.

9.1 Households

Each household $i = 1, 2, ..., N$ derives utility from consumption in two periods, c^i and z^i:

$$U^i = \log c^i + \beta E\left(z^i\right),$$

subject to the budget constraints in the two periods:

$$c^i + a^i = e^i$$

$$z^i = (1+r)\,a^i + ws^i + \frac{a^i}{A}\theta K - p_\ell \frac{a^i}{A}\theta K + \eta^i,$$

where a^i is i's saving, $A \equiv \sum_{i=1} a^i$ denotes aggregate savings; K is the contestable prize; $0 \leq \theta < 1$ is a measure of institutional quality measuring the degree of property rights protection which captures the extent of aggregate resources that can be extracted because of rent seeking behaviour; $0 < p_\ell < 1$ is the price that households pay for lobbying services, which are required to generate rent extraction; η^i is profits made by various firms and distributed to household i; and e^i is an initial endowment (e.g. initial labour income). Households receive productivity individual-specific shocks s^i that determine their labour income in the second period. In particular, s^i is assumed to be either high or low, so that $s^{i,low} < s^{i,high}$, with probabilities q and $1-q$ respectively. For simplicity, we assume $q = 1 - q = 0.5$.

The Euler equation for a^i is:

$$\frac{1}{c^i} = \beta\left(1 + r + \frac{1}{A}(1-p_\ell)\theta K\right).$$

Note that the simplified framework implies that savings and wealth are not affected by household income risk (this is due to the linear utility function in the second and last period) and that income heterogeneity in the second period does not affect saving and wealth accumulation in the first period. Hence, wealth inequality is driven only by potential differences in e^i. To simplify further the analysis, we set $e^i = e$, $\forall i$, implying that savings are the same for all households and thus we focus on the effect of rent seeking on income inequality, i.e. in differences in z^i.

9.2 Production sector

In the production sector, each producer $f = 1, 2, ..., N$ acts competitively and uses a linear production function of the form

$$y^f = A^k k^f + A^l l^f,$$

where A^k, $A^l > 0$ are parameters. Profits are given by

$$\eta^f = y^f - r^f k^f - w l^f,$$

so that the zero-profit conditions determine the factor returns:

$$r^f = A^k$$

$$w = A^l.$$

9.3 Lobbying sector

In the lobbying sector, each lobbying firm $\ell = 1, 2, ..., N$ uses its labour input, l^ℓ, which is paid the competitive wage w, to produce and sell rent seeking services, θK, to households. Assuming a linear technology for each firm:

$$\frac{\theta K}{N} = A^\ell l^\ell.$$

where $A^\ell > 0$ is a technology parameter. The profit of each ℓ is given by:

$$\eta^\ell = p_\ell A^\ell l^\ell - w l^\ell.$$

A zero-profit condition requires:[17]

$$p_\ell = w / A^\ell.$$

9.4 Financial sector

In the financial sector, there are $b = 1, 2, ..., N$ firms selling financial services to households and firms. They accept deposits from households, A, paying them a return r and make loans to production firms, K^f, charging them with a rate r^f. But the total loans given to those firms are only a fraction of total

[17] We restrict our attention below to the interesting case where $p_\ell < 1$, which requires, given the assumption of linear production, that $A^\ell > A^l$.

deposits, i.e. $K^f = (1-\theta)\,A \equiv (1-\theta)\,K$, because, in equilibrium, $K \equiv A$, so that $\theta A \equiv \theta K$ can be extracted by rent seekers.

The profit of each b is

$$\eta^b = (1+r^f)K^f - (1+r)A = (1+r^f)(1-\theta)K - (1+r)K,$$

which implies a zero profit condition:

$$r = (1+r^f)(1-\theta) - 1.$$

9.5 Rent seeking as self-insurance (given prices)

As a first step, we consider the implications of rent seeking for inequality given factor prices, r, r^f, w and p_ℓ. This can be thought of as a partial equilibrium solution or a kind of myopia on behalf of rent seekers. Since, as said above, $A = K$ in equilibrium, combining the three first-order conditions of the household (i.e. its two budget constraints and the Euler condition), we simply have for savings:

$$a \equiv a^i = e - \frac{1}{\beta[1+r+(1-p_\ell)\theta]}. \tag{17}$$

In the second period, some households happen to be lucky, receiving $s^{i,high}$, and some others happen to be unlucky, receiving $s^{i,low}$. Using the above equation for a into the household's budget constraint in the second period, we have respectively for the lucky and the unlucky ones (profits are zero in equilibrium):

$$z^{i,high} = y^{i,high} = [1+r+(1-p_\ell)\theta]a + s^{i,high}w = e[1+r+(1-p_\ell)\theta] - \frac{1}{\beta} + s^{i,high}w$$

$$z^{i,low} = y^{i,low} = [1+r+(1-p_\ell)\theta]a + s^{i,low}w = e[1+r+(1-p_\ell)\theta] - \frac{1}{\beta} + s^{i,low}w.$$

Let us use the ratio of the two second-period incomes as a measure of inequality:

$$\frac{y^{i,high}}{y^{i,low}} = \frac{e[1+r+(1-p_\ell)\theta] - \frac{1}{\beta} + s^{i,high}w}{e[1+r+(1-p_\ell)\theta] - \frac{1}{\beta} + s^{i,low}w}.$$

Given prices r, p_ℓ and w, simple differentiation of this ratio with respect to θ implies $\frac{\partial \frac{y^{i,high}}{y^{i,low}}}{\partial \theta} < 0$; namely, a deterioration in institutional quality reduces inequality other things equal. This happens because weak institutions encourage savings (note that θ increases savings in (17)) and higher savings work to reduce the importance of divergence in labour income (earnings luck and inequality) in the second period. Rent seeking in this context works as an *ad hoc* insurance mechanism that reduces inequality.

9.6 The importance of resource extraction

In general equilibrium, $r = (1 + r^f)(1 - \theta) - 1$, $p_\ell = w/A^\ell$, $r^f = A^k$ and $w = A^l$. Then, saving becomes

$$a = e - \frac{1}{\beta[(1 + r^f)(1 - \theta) + (1 - w/A^\ell)\theta]} \tag{18}$$

and in turn inequality becomes

$$\frac{y^{i,high}}{y^{i,low}} = \frac{e[(1 + A^k)(1 - \theta) + (1 - A^l/A^\ell)\theta] - \frac{1}{\beta} + s^{i,high}A^l}{e[(1 + A^k)(1 - \theta) + (1 - A^l/A^\ell)\theta] - \frac{1}{\beta} + s^{i,low}A^l},$$

which is a closed-form analytical solution. Now $\frac{\partial \frac{y^{i,high}}{y^{i,low}}}{\partial \theta} > 0$ That is, the general equilibrium effect of θ is opposite from the partial equilibrium one. When the effect of resource extraction is accounted for in general equilibrium, a deterioration in institutional quality increases inequality, due to the distorting effect on the interest rate r which implies that θ decreases savings (see (18)).