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Abstract

This paper studies the cycles of nationalization and privatization in resource-rich economies. It starts with a discussion of available evidence on the drivers and consequences of privatization and nationalization. Then it develops a static and dynamic model of the choice between private and national regimes for the ownership of natural resources. In the model, the choice is driven by a basic equality-efficiency tradeoff: national ownership results in more redistribution of income and more equality but undermines incentives for effort. The resolution of the tradeoff depends on external and domestic conditions that affect social welfare under each regime. We characterize how external variables –such as the commodity price– and domestic ones –such as the tax system– affect the choice of private vs. national regimes. Our analysis therefore identifies the determinants of the observed cycles of privatization and nationalization and is consistent with key stylized facts.

Keywords: Privatization, Nationalization, Institutions, Natural Resources, Oil

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1 Introduction

One of the most salient institutional reforms in the last 25 years has been the privatization of commercial enterprises around the world (Chong and Lopez de Silanes, 2005). In the last decade, however, the benefits of privatization have been called into question, and many countries have moved to re-nationalize some of these enterprises (Manzano and Monaldi, 2008; and Stroebel and van Benthem, 2013). In no area has this been more prevalent than in the exploitation of commodities in resource-rich economies (Kobrin, 1984; Rigobon, 2010). The historical experience suggests that many of these economies have moved back and forth between private and national regimes (Minor, 1994; and Chua, 1995). This is an example of the instability of institutions, defined as the set of rules and norms under which the economy functions.

This paper studies the cycles of privatization and nationalization in resource-rich economies. Such cycles occur mainly in countries with incipient institutional development and poor governance and, in turn, generate further institutional instability. The paper starts by discussing evidence obtained from both cross-country econometric studies and in-depth regional and country case studies. Four observations emerge.[1] First, nationalizations and privatizations are recurrent phenomena, which often come in waves common to several countries. Second, privatization - nationalization cycles tend to occur more often in the natural resources and utilities sectors. Third, nationalization of natural resource industries tends to happen when the price of the corresponding commodity is high. And, fourth, privatization leads to higher productivity but also larger inequality, and nationalization is more likely when inequality rises.

These observations motivate and provide a context for the main contribution of the paper, a model of the choice between private and national regimes for the exploitation of natural resources. The model is built around a basic tradeoff between equality and efficiency. Greater

[1] In the working paper version of the paper (Chang, Hevia, and Loayza, 2010), we present an analytical narrative of three illustrative case studies of repeated nationalization and privatization of a natural-resource industry (Bolivia and hydrocarbons, Venezuela and oil, and Zambia and copper). We focus on the periods before and after privatization and nationalization, with the objective of relating regime shifts to the behavior of the price of the commodity, its level of production and capital investment, the taxes and other fiscal revenues derived from its exploitation, and the average income and degree of inequality of society at large.

equality is obtained under public ownership of a natural resource, while more efficiency obtains when the resource is in private hands. The connection between ownership and the equality-efficiency tradeoff is given by the incentives for effort that each regime provides to economic agents. In the private regime, there is a differential compensation scheme that depends on observed productivity, thus encouraging agents to increase effort.[2] Under the national regime, the government cannot credibly commit not to equalize income ex-post, thus generating equality but also minimal individual effort.[3]

The resolution of the tradeoff depends on external and domestic conditions that affect national welfare under each regime. Hence our framework allows us to study how external variables –such as the price of the commodity in question– and domestic ones –such as the tax regime and financial constraints– affect the choice of private or national regimes. As external and domestic conditions fluctuate, cycles of privatization and nationalization emerge.

The government's inability to credibly commit not to redistribute after effort and production have been done (in the state ownership regime) and not to take over the sector (in the private ownership regime) is a distortion that generates realistic and complex strategic issues that are identified in our analysis. Under state ownership, domestic agents understand that the government will ultimately wipe away any relative gains from individual effort, which is unobservable; as a result, effort is inefficiently low. Privatization can be seen as a partial solution in which the resource is sold to outsiders or foreign investors, who are profit oriented, do not care about redistribution, and hence are able to provide better incentives for effort. Thus, private ownership enhances efficiency and, in fact, serves as a commitment device for the government. However, such a device comes at a cost, as the private regime results in more unequal consumption for domestic agents. Moreover, this cost also includes the profits appropriated by the investors if, as we assume, their welfare is not part of national welfare.

The decision to privatize then depends on the relative merits of these benefits and costs,

[2]In the model, work effort is a proxy for all activities that are affected by economic incentives and that may have an impact on productivity. From a long run perspective, therefore, it does not only represent labor but also investment in human and physical capital, as well as managerial and entrepreneurial activity.

[3]This assumption is similar in spirit to that of Perotti (1995), but our model and analysis are quite different.

which in turn depend on the world price of the resource and a set of domestic conditions. It is worth noting that the net benefits of privatization are themselves partly determined by the expectations of prospective buyers about future government actions. This is because, at the time of privatization, prospective buyers realize correctly that the government may decide to re-nationalize the resource if its price increases sufficiently. This reduces the amount that the country can raise when the resource is privatized.

The model illustrates how political tension about increased inequality and associated conflicts can emerge as a by-product of the solution of the equity-efficiency problem. Our discussion assigns no direct role to other political characteristics, such as ideological preferences or political regime, which are sometimes stressed in the literature. The conventional wisdom (for instance, Biglaiser and Danis, 2002; Jensen, 2008; Li, 2009; and Mahdavi, 2014) is that democratic regimes are more likely to privatize and autocratic regimes are more prone to nationalize . More nuanced conclusions stress the importance of political checks and balances in reducing the likelihood of expropriation even in autocracies (Li, 2009) and the relevance of populist tendencies in increasing the possibility of nationalization even in democracies (Albornoz, Galiani, and Heymann, 2012). Our model abstracts from these political considerations, not to suggest that they are unimportant but, rather, to emphasize the economic forces behind the drive for privatization and nationalization.[4]

Our theoretical contribution is related to a few recent papers. Rigobon (2010) studies oil production and profit-sharing contracts between a government and a private company. In this model, the government defaults on the contract when profits exceed some exogenous threshold intended to capture the expropriation of "excess" rents. Guriev, Kolotilin, and Sonin (2011)

[4]In outlining a mechanism through which concentrated natural resources are linked to regime instability and uneven production outcomes, our paper is also linked to the large literature on the "natural resource curse" that follows seminal work by Sachs and Warner (1995). This literature has studied whether natural resource abundance contributes to slow economic growth and poor human development. The evidence provides a nuanced conclusion: Natural resource abundance can have a negative development impact if it is associated with irresponsible macroeconomic policies or poor governance. There is disagreement, however, on the mechanism and direction of causality. See Alexeev and Conrad (2009, 2011), Bulte, Damania, and Deacon (2005), Auty (2001a, 2001b), Bulte, Damania, and Deacon (2005), Manzano and Rigobon (2003), and Atkinson and Hamilton (2003).

considers a contract between a risk-neutral government and a risk-neutral foreign firm whereby the government delegates oil production to the firm. Importantly, the firm can renege on the contract by retaining all the revenues without paying taxes or royalties to the government in a given period. This implies that taxes cannot be too high and, consequently, that expropriation occurs if oil prices are high enough. Finally, Stroebel and van Benthem (2013) consider a contract between a risk-averse government and a risk neutral firm. The optimal contract provides a trade-off between insurance (provided by price-contingent taxes paid by the firm) and expropriation (which entails benefits and costs to the government). In this model, expropriation occurs in equilibrium due to an asymmetry of information whereby the costs of nationalization are private information (to the government). The government expropriates the private firm when the price of oil is high or when expropriation cost is low.

While related to our model, these papers focus on the interaction between a single domestic agent (the government) and a (foreign) private firm; moreover, they concentrate on the expropriation incentives and decision. Our model considers a diversity of domestic economic agents and deals not only with nationalizations but also with the cycle that includes privatizations. Our approach allows us to consider the trade-off between efficiency and equity that is generated by the combination of moral hazard (by workers) and commitment problems (by the government).

The rest of the paper proceeds as follows. Section 2 reviews the existing empirical evidence to derive a set of key observations surrounding the occurrence of privatization and nationalization. Sections 3 and 4 develop a model on the choice between private and national regimes. Section 3 describes a one period version which takes the current regime as given, while Section 4 introduces a dynamic version where the possibility of regime shifts arises. By calibrating and simulating the model, we explore and discuss the characteristics under which each regime is more likely to be prevalent and the determinants of the timing of regime changes. Section 5 concludes. Technical proofs and a description of numerical algorithms to compute equilibria are delayed to an Appendix.

2 Observations from the Empirical Literature

We now present four key observations that motivate our theoretical examination. These are derived from both cross-country econometric studies and in-depth regional and country case studies. They are primarily focused on developing countries, where the cycles of nationalization and privatization have been most prevalent.

Observation 1: Nationalizations and privatizations are recurrent phenomena, which often come in waves common to several countries. Kobrin (1984) analyzed expropriations in 79 developing countries over the period 1960-79. It finds that expropriations grew in the 1960s, peaked in the early 1970s and declined afterwards. Minor (1994) and Shafik (1996) extend Kobrin's study to include the period up to 1993. They find that in the late 1980s and early 1990s, as many as 95 countries around the world experienced extensive privatization processes. Most recently, however, Manzano and Monaldi (2008) and Stroebel and van Benthem (2013) report the opposite trend in the last decade, albeit in a smaller group of countries (including, for instance, Algeria, Bolivia, China, Ecuador, Russia, and Venezuela). For some of these countries, the current wave of nationalization is only the latest chapter of a recurrent process, as they had previously experienced nationalizations in the 1970s and privatizations in the 1990s (see also Mahdavi, 2014).

Chua (1995) is arguably the most comprehensive historical study of privatization and nationalization cycles, with focus on Latin America and Southeast Asia. In Latin America (most prominently, Argentina, Brazil, Chile, Mexico, Peru, and Venezuela), a first wave of privatization extended from the 1870s to the 1920s. Partly as reaction to the Great Depression, nationalizations became quite frequent and extensive in the 1930s. After World War II, a second tide of privatization occurred, only to be reversed under the populist regimes of the 1960s and 1970s. Two decades later, in the early 1990s, the pendulum fluctuated back to privatization, which, as mentioned above, occurred in a massive scale. In Southeast Asia (particularly, Malaysia, Pakistan, and Thailand), the cycle started later, as they attained their national independence.

Initially, most of these economies were privately run. This changed in the late 1960s and early 1970s, when extensive nationalizations occurred, as they did in Latin America. Also coinciding with the Latin American wave, many state-owned companies in Southeast Asia were privatized in the late 1980s and early 1990s.

Observation 2: Privatization - nationalization cycles tend to occur more often in the natural resources and utilities sectors. Kobrin (1984) documents that in the last five decades expropriations encompassing large portions of the economy do occur, but they are less frequent than selective expropriations and have been mostly concentrated in a dozen of countries. In its historical account, Chua (1995) finds that in the majority of countries under analysis, utility and natural resource companies are significantly more prone to undergo nationalization and privatization regime shifts. Chua's account of the ownership swings of oil exploitation companies in Latin America is particularly revealing.

There is a large diversity within natural resources, and a specific type of these resources has been most subject to privatization and nationalization cycles. Kobrin (1984), Chua (1995), and Duncan (2006) single out the mineral and fuel sectors. Their geographic location and production technology make them different and more prone to nationalizations. Auty (2001a, 2001b) differentiates between "point" resources such as oil fields and mineral mines and "diffuse" resources such as land, water, and others related to agriculture. "Point" resources have a concentrated geographic location and involve large, fixed, and specialized capital investment. This makes them particularly vulnerable to political control and potentially abuse, including expropriation.

Observation 3: Nationalization of natural resource industries tends to occur when the price of the corresponding commodity is high. Duncan (2006) investigates the causes of expropriation in the mineral sectors of exporting developing countries. In the study, expropriation is defined as any act by which a government gains a greater income share than it is entitled to under the original contract with the foreign investor. The sample analyzed consists of the eight largest

developing country exporters for seven major minerals. Covering the period 1960-2002, Duncan (2006) uses probit regressions to estimate the effects of price booms and political and economic crises on the probability of expropriation. The results indicate that price booms are significantly positively correlated with instances of expropriation.

Guriev, Kolotilin, and Sonin (2011) examines the determinants of nationalization in the oil sector, using panel data for 161 countries for the period 1960-2002. The paper presents logit pooled regressions of nationalization events on oil price shocks and the quality of government institutions, controlling for country fixed effects and per capita GDP, among other variables. The results show that governments are more likely to practice expropriations when the oil price is high and when government institutions are weak. Analyzing the recent trend in the Latin American oil sector, Manzano and Monaldi (2008) argues that the new wave of nationalizations is induced largely by the increase in international oil prices, especially when tax systems are regressive and do not account for price contingencies (see also Stroebel and van Benthem). Likewise, Duncan (2006) argues that a combination of high commodity prices and low profit sharing from private firms to host governments gave the latter large incentives to expropriate.

Observation 4: Privatization leads to higher productivity but also larger inequality, and nationalization is more likely when inequality rises excessively. Chua (1995) concludes that nationalization in Latin America and Southeast Asia was promoted against not only foreigners but also domestic residents who were perceived as unfairly privileged. Private ownership and management of utility and natural resource companies was seen as worsening the inequality already present in these societies. Likewise, Albornoz, Galiani, and Heymann (2012) stresses the distributional effects of foreign investment as an important driver of expropriation.

Beyond these aggregate considerations, there are systematic differences in wage and labor outcomes in firms under private versus state ownership regimes; these differences turn out to be relevant to understand the mechanisms explored in the model below. State-owned enterprises (SOEs) tend to employ more people than private firms do, and they compensate their workers in a more egalitarian way. Using a sample of the largest 500 corporations worldwide according

to sales in 1975, 1985, and 1995, Dewenter and Malatesta (2001) finds that government firms on average employ more workers, other things constant. Brainerd (2002) confirms this result in the case of Russia. Zhao (2002) uses a survey of Chinese urban households in 1996 and finds evidence that on average, employees of SOEs earn less than those in private firms but this varies according to skill. Specifically, unskilled workers in foreign enterprises earn significantly less than those in the state sector but skilled workers earn more in foreign firms. Moreover, when state-owned enterprises are privatized, employment levels typically decrease and wages for remaining employees often increase and become more dispersed. Chong and Lopez de Silanes (2003) presents a survey of 308 privatized firms in 84 countries and find that employment declines in over 78% of cases. Galal (1994) studies the post-privatization performance of 12 firms in Britain, Chile, and Mexico and finds that wages for remaining workers are often higher.

The flip side of the higher egalitarianism among workers in SOEs is their lower productivity. For example, Vining and Boardman (1992) finds that large SOEs worldwide are significantly less profitable and less efficient (by employee-to-sales ratio) than privately owned firms. Wolf (2009) finds similar results on profitability for the 50 largest oil and gas companies worldwide over 20 years. Dewenter and Malatesta (2001) concludes that labor productivity (sales-to-employee ratio) significantly drops following privatization in a cross-country sample of 63 privatized firms. Similarly, La Porta and Lopez de Silanes (1999) finds that Mexican SOEs which are privatized increase profitability and decrease employment. Moreover, it argues that workers are paid higher wages in exchange for greater effort.

3 A Single Period Model

This section and the next develop a model of an industry that can operate under either a private ownership regime or a state ownership regime. In this section we confine attention to one typical period given the ownership regime, and focus on the determination of the net benefits of each regime. This hinges on a crucial efficiency-equity tradeoff derived from a moral

hazard problem, together with the inability of the government to commit not to redistribute income under state ownership.

We assume that the productivity of workers depends on unobservable effort.[5] Efficient contracts would then prescribe that more productive workers be paid more than less productive ones, in order to elicit the right amount of effort. While this is possible under private ownership, the government cannot refrain from equalizing the incomes of workers ex-post under state ownership. But this destroys incentives for effort. The result is that private ownership is associated with more efficiency but less equality than state ownership, which is consistent with the stylized facts identified in the previous section. Importantly, the equity-efficiency tradeoff depends on a number of parameters, such as the degree of risk aversion, as well as other exogenous data including the price of the country's resource.

3.1 Workers

We consider an economy that produces a commodity via an increasing and concave production function $F = F(L)$, where L is labor. The commodity is sold in the world market in exchange for world currency, which is taken as numeraire. The commodity price, denoted by p, is exogenous to the economy under analysis.

The economy is populated by a continuum of ex-ante identical workers of measure N. The labor supply of worker i, denoted by l_i, is a random variable whose distribution depends on the worker's effort, a_i. One can interpret l_i as the worker's productivity for the job, which may be uncertain but is enhanced, on average, by effort spent on education or training. Crucially, everyone observes labor but effort is private information of the worker.

Naturally, exerting more effort is beneficial for productivity. Assume that l_i can be either high (l_H) or low ($l_L < l_H$), and that the probability of high productivity is an increasing

[5] Work effort in the model represents, in general, economic activities that are influenced by remuneration incentives and that may, in turn, affect production and productivity. They include not only labor input but also human and physical capital investment, as well as managerial and entrepreneurial behavior. As in the case of work effort in the model, these activities are subject to moral hazard in the sense that their compensation is tied to observed productivity and not only exercised input.

and concave function of effort, $\Pr(l_i = l_H|a) = \pi(a)$. Given effort, the realization of labor productivity is i.i.d. across workers. By the law of large numbers, if all workers spend effort a, the actual proportion of workers with high productivity equals $\pi(a)$.

The worker faces a labor market characterized by a wage schedule $\{y_H^*, y_L^*\}$, where y_H^* and y_L^* are the payments to a worker with high and low labor productivity, respectively. Total income of a worker with productivity l_i is $y_i^* + T$, where T is a lump-sum transfer.

Denote the utility of income by $u(c)$ and the cost of effort by $\phi(a)$. We assume $u' > 0 > u''$, $\phi(0) = \phi'(0) = 0$ and $\phi', \phi'' > 0$ for all $a > 0$.[6] Then, the worker chooses a to maximize her expected utility

$$\max_{a \geq 0} \pi(a) u(y_H^* + T) + (1 - \pi(a)) u(y_L^* + T) - \phi(a). \tag{1}$$

The first order necessary condition is

$$\pi'(a) [u(y_H^* + T) - u(y_L^* + T)] - \phi'(a) = 0 \tag{2}$$

This has an obvious interpretation. $\phi'(a)$ is the cost of increasing effort by an infinitesimal unit; the gain is that, with increased probability, $\pi'(a)$, the agent gets to consume $y_H^* + T$ instead of $y_L^* + T$. Under our assumptions, $a > 0$ if and only if $y_H^* > y_L^*$. Furthermore, a is increasing in the wage differential.[7]

We now turn to the determination of wages, taxes, and industry ownership regime.

3.2 State Ownership

Consider a period in which the industry is under state ownership. We make two assumptions about this regime: (i) the government maximizes an equally weighted sum of the utilities of domestic workers, and (ii) the government chooses a wage schedule and taxes *after* effort has been spent and individual productivity is observed.

[6] $\phi(0) = 0$ is a normalization. $\phi'(0) = 0$ guarantees that positive effort is chosen whenever $y_H^* > y_L^*$.

[7] To see this, let $\Delta = y_H^* - y_L^*$, and rewrite (2) as $u(\Delta + y_L^* + T) - u(y_L^* + T) = \gamma(a)$, where $\gamma(a) = \phi'(a)/\pi'(a)$. Differentiating this expression with respect to Δ, and noting that $\gamma'(a) > 0$, gives $da/d\Delta > 0$.

The last assumption is crucial and can be justified on the basis of political pressures. Any wage contract offered in advance of the choice of effort is assumed to be non-credible, as the state would always be able to renegotiate the terms of the contract. Alternatively, one may assume that the state can impose taxes and transfers to effectively undo any prior contract.

Given the probability π (and assuming without loss of generality that $T = 0$), the planner chooses y_H and y_L to maximize the sum of workers' utilities:

$$N\left[\pi u(y_H) + (1-\pi)u(y_L)\right] \text{ subject to}$$

$$N\left[\pi y_H + (1-\pi)y_L\right] = pF(N\left(\pi l_H + (1-\pi)l_L\right)).$$

The first order conditions with respect to y_H and y_L implies $u'(y_H) = u'(y_L)$ or, equivalently, $y_H = y_L$. Intuitively, since the wage schedule no longer distorts effort choice, the government chooses it to prevent consumption inequality. But, as agents predict that their compensation does not depend on productivity, they exert the minimum amount of effort, $a_S = 0$. Hence, aggregate labor is $L_S = N\left[\pi(0)l_H + (1-\pi(0))l_L\right]$, which is the smallest possible labor supply.

For future reference, note that the welfare of the typical worker under state ownership is the following function of the commodity price

$$U_S(p) = u(pF(L_S)/N).$$

We summarize these results in the following proposition

Proposition 1: *Under state ownership, the government equalizes consumption across agents and workers exert the minimum amount of effort. Given the price p, labor and output fall to their smallest possible values.*

3.3 Private Ownership

When the industry operates under private ownership, private owners can commit to pay different amounts to workers according to their productivity. This implies that private ownership will result in more efficient effort choice. But this comes at the expense of equity.

We assume an industry structure in which private owners compete for workers. There is a continuum of firms of measure 1. Each firm produces domestic goods via the production function $F(L)$, sells the goods at the price p, and pays a dividend tax τ and a sales tax θ. The receipts from these taxes are rebated lump-sum to the workers.[8]

Given the wage schedule $\{y_H^*, y_L^*\}$ of what highly productive and less productive workers are paid in the market, each firm offers its own wage schedule $\{y_H, y_L\}$ and chooses the number of workers n and a suggested effort level a to maximize expected profits

$$\{p(1-\theta)F(n[\pi(a)l_H + (1-\pi(a))l_L]) - n[\pi(a)y_H + (1-\pi(a))y_L]\}(1-\tau)$$

subject to an incentive compatibility (IC) and an individual rationality (IR) constraints,

$$\begin{aligned} u(y_H+T) - u(y_L+T) - \gamma(a) &= 0 \\ \pi(a)u(y_H+T) + (1-\pi(a))u(y_L+T) - \phi(a) &\geq U^*. \end{aligned} \tag{3}$$

where $\gamma(a) = \phi'(a)/\pi'(a)$.

The IC constraint requires the wage schedule and suggested effort to be consistent with the worker's optimal effort choice.[9] The IR constraint requires the proposed contract to deliver a

[8] Alternatively we could assume a single firm. This approach, however, delivers the extreme result that low productivity workers are paid zero under the optimal contract. With our industry structure all workers have an outside option that imposes a lower bound on their labor incomes. In any case, results are qualitatively the same under both industry structures.

[9] Using the worker's first order condition as a constraint on the principal's problem does not guarantee the optimality of the contract. This 'first order approach' is valid if the distribution function of labor endowment conditional on effort satisfies simultaneously a monotone likelihood ratio and a convexity conditions (Rogerson, 1985). These conditions are satisfied in our environment.

level of utility at least as large as the utility that the worker can get in the market, given by

$$U^* = \pi(a^*)u(y_H^* + T) + (1 - \pi(a^*))u(y_L^* + T) - \phi(a^*).$$

The first order condition with respect to n is

$$p(1-\theta)F'(n\ell(a))\ell(a) = \pi(a)y_H + (1 - \pi(a))y_L, \tag{4}$$

where $\ell(a) = \pi(a)l_H + (1 - \pi(a))l_L$ is expected labor given effort a. At the optimum, the expected increase in revenue to the firm of hiring one more worker equals the expected wage payment to the additional worker.

The first order conditions with respect to y_H and y_L can be written, respectively, as

$$\frac{n}{u'(y_H + T)} = \lambda + \frac{\eta}{\pi(a)} \tag{5}$$

$$\frac{n}{u'(y_L + T)} = \lambda - \frac{\eta}{1 - \pi(a)}, \tag{6}$$

where $\eta(1-\tau)$ and $\lambda(1-\tau)$ are the multipliers on the IC and IR constraints.

To interpret these conditions, suppose (counterfactually) that the IC constraint does not bind ($\eta = 0$). In this case, the first order conditions imply $y_H = y_L$. The firm would pay the same amount to workers regardless of their productivity because it would be the cheapest way to pay workers their outside option of U^*. It is apparent, then, that the need to provide incentives for effort creates a wedge between y_H and y_L which is costly to the firm. This wedge is induced by the multiplier η. (See Lemma 2 and its corollary below.)

Lastly, the first order condition with respect to effort, after using incentive compatibility, is

$$n\pi'(a)\left[p(1-\theta)F'(n\ell(a))\left(l_H - l_L\right) - \left(y_H - y_L\right)\right] = \eta\gamma'(a) \tag{7}$$

The left hand side is the increase in expected profit of a marginal increase in a. The right hand

side is the marginal cost of the incentive compatibility constraint: a small increase in a implies that the difference between $u(y_H + T)$ and $u(y_L + T)$ must increase by $\gamma'(a)$. To obtain the associated cost, we multiply $\gamma'(a)$ by the shadow cost of the incentive constraint, η.

The following lemmas and corollary characterize the properties of the optimal contract.

Lemma 1: *The IR constraint is binding.*

Lemma 2: *The IC constraint multiplier is positive,* $\eta > 0$.

Corollary: *The optimal contract is monotone, that is,* $y_H > y_L$.

We now consider the industry equilibrium. Because all firms are equal, in equilibrium $n = N$ and $\{y_H, y_L\} = \{y_H^*, y_L^*\}$. In addition, the government rebates the collected taxes to the workers. Thus, the government budget constraint is

$$TN = \tau \left[p(1-\theta)F(N\ell(a)) - N\left(\pi(a)y_H^* + (1-\pi(a))y_L^*\right)\right] + \theta pF(N\ell(a)) \tag{8}$$

Collecting results, the system of equations (3 - 8), with $n = N$ and $\{y_H, y_L\} = \{y_H^*, y_L^*\}$, determine the six $\{y_H^*, y_L^*, a^*, T^*, \lambda, \eta\}$. The solution implies that the average worker has utility

$$U_P(p) = \pi(a^*)\, u(y_H^* + T^*) + (1-\pi(a^*))u(y_L^* + T^*) - \phi(a^*).$$

Like in the state ownership regime, U_P and the industry equilibrium under private ownership depend on the resource price p.

For future reference, we define the before-dividend-tax indirect return function of the firm,

$$R(p) = p(1-\theta)F(N\ell(a^*)) - N[\pi(a^*)y_H^* + (1-\pi(a^*))y_L^*].$$

Results under private ownership are summarized in the following proposition,

Proposition 2: *Under private ownership, workers exert positive effort and the high pro-*

ductivity workers are paid more than the low productivity ones. The optimal contract induces consumption inequality and imperfect risk sharing.

3.4 Efficiency and Welfare

Positive effort under private ownership implies that effective labor, production, and average consumption are all greater than under state ownership. This, however, comes at the cost of consumption inequality and appropriation of profits by private owners.

The constraint $\tau < 1$ is crucial to obtain a non-trivial tradeoff between the national and private regimes. In particular, if dividend taxes converge to 1 and sales taxes are set to zero, the government is able to attain the ex-ante constrained-efficient allocation under a private ownership regime –the allocation that a benevolent planner that is subject to the same information constraints as private firms would choose. In effect, the private regime acts as a commitment device which, together with the right taxes, implements the constrained-efficient allocation. This is summarized in the next lemma.

Lemma 3: *A private-ownership regime with* $\theta = 0$ *and* $\tau \to 1$ *attains the ex-ante constrained-efficient allocation.*

For the rest of the paper we maintain the realistic assumption that $\tau < 1$. This is also the only sensible option, if only because in the full dynamic model no privatization would ever be possible if potential buyers know that they will pay 100% in taxes on their profits.

Under this assumption, there are two opposing forces at any price p. On the one hand, a state ownership regime induces perfect risk sharing across workers, but at the cost of low aggregate productivity. On the other hand, by providing incentives to exert effort, private firms are able to achieve higher labor productivity. This higher output together with the lump-sum transfers obtained from the taxation of sales and profits benefit not only high ability workers but also the low ability ones. However, because private owners appropriate a fraction of total profits –and the possible existence of distortionary sales taxes– the allocation under private ownership

regime is not constrained efficient, creating a non-trivial tradeoff between the private and state ownership regimes.

Our discussion thus identifies the key role of the assumption that the government cannot refrain from redistributing income *ex-post* if able to. If the government could pre-commit not to do that, state ownership would be preferred to private ownership, as the government would be able to elicit an efficient amount of effort without having to forgo the profits extracted by owners in a privatized regime. In that case, our analysis indicates that only state ownership would be observed (and we would have to search for a different explanation for the cycles of privatization and nationalization).[10]

The counterpart to the last observation is that privatization may be valuable to the country because it may serve as a commitment device, albeit imperfect. This would be reflected, in particular, by the fact that productivity is higher under private ownership than under state ownership. This is worth noting, because increased productivity has been often mentioned as an advantage of privatization, but for reasons that are quite different from ours. For instance, sometimes it is said that foreign owners would bring better know-how or organizational skills to privatized ventures. While this may be true, the positive incentive effect on domestic effort may be an additional, complementary upshot of privatization.

3.5 Numerical Explorations

Further understanding of the properties of the model can be obtained by resorting to numerical methods. We view our numerical experiments as providing further insights into the working of

[10]Readers might notice that, in contrast with our assumptions about redistributing labor income, in a private regime the government can commit not to increase profit taxes or sales taxes after production. One justification is essentially the same as the one for assuming $\tau < 1$: if the government could tax profits ex post, then it would expropriate all profit. Then privatization would not be feasible, and we would have to look for a different theory. In practice, and presumably for these reasons, privatization contracts often stipulate tax rules with the purpose of preventing the government from taxing profits ex post. Our assumption is, effectively, that such rules cannot be reneged upon unilaterally unless there is nationalization.

A complementary view is that, in our model, privatization serves as a commitment device for the government: the government commits neither to equalize workers' incomes (so as to encourage effort) nor to tax profits ex post (to incentivize firm's activity). It is ex ante credibility which makes the privatized regime work differently from a nationalized one.

the model and not as a realistic parametrization of any privatization - nationalization episode; our model is too stylized for that purpose. In any case, however, we calibrate the model to obtain durations of privatization and nationalization regimes that resemble those observed in the hydrocarbon sector in Bolivia during the last decades.[11] This issue is discussed in more detail when we describe the computation of the dynamic version of our model.

We make assumptions about functional forms and parameter values that generate predictions that are qualitatively consistent with the empirical regularities discussed in section 2. We then perturb these parameters and analyze how changes in the environment impact the equilibrium of the model.

We assume a utility of income of the constant absolute risk aversion form,

$$u(c) = \left(1 - e^{-\gamma c}\right)/\gamma,$$

where $\gamma > 0$ is the coefficient of absolute risk aversion; a cost of effort function given by

$$\phi(a) = \varphi a^2/2\,,$$

where $\varphi > 0$; a Cobb-Douglas production function,

$$F(L) = AL^{\alpha},$$

where A is the level of productivity and $0 < \alpha < 1$; and a function transforming effort into probabilities of drawing high labor endowment given by

$$Pr(l_i = l_H|a) = \pi(a) = 1 - \delta e^{-\nu a},$$

where $0 < \delta < 1$ measures the probability of low endowment when effort is zero and $\nu > 0$ measures the sensitivity of the probability to changes in effort.

[11] Chang, Hevia, and Loayza (2010) presents an analytical narrative of the case of Bolivia and hydrocarbons.

In our baseline parameterization, the labor endowment of a worker that draws high productivity is $l_H = 1$, and that of a worker with low productivity is $l_L = 0.1$. That is, high labor endowment workers are ten times more productive that low labor endowment workers. The coefficient of absolute risk aversion is set at $\gamma = 2.5$, and the cost of effort parameter is $\varphi = 1$. We assume that the probability of drawing low productivity if effort is zero is $\delta = 0.99$, and the sensitivity of this probability to changes in effort is $\nu = 2$. The level of technology is set at $A = 0.15$, total population is $N = 1$, and the exponent on labor in the production function is $\alpha = 0.66$. Finally, taxes are set at $\tau = 0.30$ and $\theta = 0.30$. Table 1 summarizes the baseline parametrization.

Given these assumptions, it is straightforward to solve for the outcome of the state ownership regime. The private ownership regime is a little more involved, as its solution is only given in implicit form by the system (3 - 8). The computation of equilibrium is described in the Appendix.

In all cases that we computed, we found two threshold prices $\underline{p} << p^*$ that partition the set of prices $[0, \infty)$ so that, for all prices below $\underline{p}$ and above p^*, welfare is larger under a state ownership regime, while for all prices between $\underline{p}$ and p^*, welfare is larger in a private ownership regime. The threshold $\underline{p}$, however, is always very close to zero (never greater than one) and disappears in the dynamic version of the model as soon as we introduce a cost of nationalizing the industry. For that reason, we focus only on the regions $(\underline{p}, p^*)$ and (p^*, ∞), which we refer to as the "low price" region and the "high price" region.[12] Figure 1 displays a typical solution of the static model.

If p is in the low price region, the private regime is worth more to the country than the national regime. The government would accept less risk sharing in exchange for the higher average labor productivity that prevails in a private ownership regime. On the other hand, if

[12] At very low prices, those below $\underline{p}$, private firms have few incentives to differentiate workers. In effect, as the price approaches zero, the optimal contract requires agents to exert zero effort. But if effort approaches zero, productivity under private ownership approaches productivity under state ownership. Therefore, state ownership becomes welfare superior for p close to zero, as all production is distributed to the workers, while under private ownership firms take part of the profits.

the commodity price is above p^*, the elimination of income inequality becomes more important, as more output is appropriated by private owners making concerns for efficiency less of an issue. In effect, higher commodity prices can be thought of as substituting for the low productivity in a state ownership regime. An implication is that pressures for national ownership are likely to grow at large values of p, which is consistent with the facts described in section 2.

Table 2 reports exercises on comparative statics to analyze how the threshold p^* changes as we change parameter values. The first row of the table reports the threshold price of the baseline parametrization. An inspection of the table reveals that all parameters have a monotonic relation with the privatization threshold p^*.[13]

Consider first the impact of changes in the preference parameters γ and φ. Table 2 shows that the threshold p^* is decreasing in the risk aversion parameter γ. This is intuitive: as workers become more risk averse, the welfare costs associated with the lack of risk sharing in a private ownership regime increase and, therefore, the set of prices for which a state ownership regime is superior than the private regime increases as well; that is, p^* decreases. Likewise, p^* is decreasing in the cost of effort parameter φ . The reasons is that, as the cost of effort increases, firms need to increase the "punishment" to workers with low labor endowment to induce them to exert effort. Hence, the lack of risk-sharing becomes more costly which reduces the nationalization threshold p^*.

Consider next the impact of changes in the probability of success parameters δ and ν. The parameter δ measures the probability of drawing a low labor endowment when effort is zero. An increase in δ has two effects: first, it reduces the value of a state ownership regime because aggregate labor declines, and second, it increases incentives to exert effort in a privatized regime because the probability of drawing high labor endowment when effort is low declines. Thus, firms are able to induce workers to exert the same amount of effort with a smaller dispersion in wages. Both effects imply that p^* is increasing in δ. Likewise, p^* is *increasing* in the sensitivity parameter ν. As ν increases, a marginal increase in effort induces a larger increase in the

[13]Table 2 does not report changes in A. The reason is that in the nationalization-privatization choice, only the product Ap matters. Thus, an increase in A immediately implies that p^* declines.

probability of success, which makes exerting effort more attractive to workers and, therefore, easier for firms to provide incentives. Thus, the benefits of a privatized regime increases with ν.

We now consider the sensitivity of the threshold price p^* to changes in the relative productivity of high and low productivity workers assuming that the average labor supply in a state-owned regime –that is, when effort is zero– remains constant. Note that these changes do not affect welfare in a state-ownership regime but they do in a private ownership regime: an increase in the relative productivity of highly productive workers increases the efficiency gains of differentiating workers through a more unequal payment schedule. In other words, an increase in the spread of labor productivity makes a private ownership regime more efficient but also more unequal. Suppose now that high ability workers are five times more productive than low ability workers –that is, l_H/l_L decreases from 10 to 5. The threshold price p^* decreases from 40.1 to 27. In effect, firms in a privately owned regime have less incentives to differentiate workers –and, therefore, increase productivity relative to a state ownership regime– because the relative gain of doing so is now lower. Thus, p^* declines.

The threshold price p^* is increasing in the technology parameter α. Intuitively, as α increases the technology becomes more 'linear' and, therefore, the degree of decreasing marginal product of labor decreases with α. In other words, the benefits of inducing workers to exert effort increases with α. Thus p^* increases as well.

Finally, consider a change in the tax code, as summarized by changes in dividend and sales taxes. An increase in the dividend tax τ increases the lump-sum transfers to the workers in a private ownership regime. This increase in T has two effects: first, more income is redistributed from the firms to the workers, and second, the differential in labor income between high and low ability workers becomes less important as their relative total income (including lump-sum transfers) becomes more equal. Thus, the welfare losses associated with consumption inequality in a private ownership regime decline, making private ownership more desirable, as reflected

by a higher p^*.[14] Likewise, p^* is increasing in the sales tax θ. A change in the sales tax has a similar impact as an increase in τ in terms of the change in incentives through the increase in lump-sum transfers T. The change in θ, however, has an additional impact on the firm's behavior since, from the firm's point of view, a higher θ is equivalent to a lower price p. Each firm must reduce wages (y_H and y_L), which implies again that transfers are a higher share of each workers' income, reducing consumption inequality under private ownership.

4 The Dynamics of Privatization and Nationalization

4.1 Multiperiod Version of the Model

In this section we study the full dynamic version of the model. Time is discrete and denoted by $t = 0, 1, ..., \infty$. Workers are infinitely lived and discount future utilities with the discount factor β. Firms are also infinitely lived and discount future profits with the discount factor $1/(1+r)$. To simplify the model, we assume that workers cannot borrow or save.

The price of the economy's resource is now assumed to follow an exogenous Markov process, which is the only source of aggregate uncertainty. The timing of events is as follows. We say that the industry was *privatized* in period $t-1$ if, at the end of that period, firms were privately owned. Otherwise, we say that the industry was in a *state ownership* regime. At the beginning of period t, the price p_t is realized, and then the government decides whether to keep the regime the same or to switch to the other regime. After the privatization - nationalization decision is made, production and consumption take place.

As before, we assume that the government is benevolent in that it maximizes the welfare of the average worker. Here, though, the government's regime choice is an intertemporal decision problem, in which the stochastic behavior of the price p_t needs to be taken into consideration in relation with various costs and benefits.

[14] In contrast with a competitive industry, a change in τ does affect the decisions of firms because it modifies the incentive compatibility constraint of workers through a change in the lump-sum transfer T.

Our results in the preceding section can now be regarded as the one-period equilibrium industry outcomes under either private ownership or state ownership. In particular, we showed how to compute the average worker's payoffs under either regime, U_P and U_S respectively, and how those payoffs depend on the price p_t.

To complete the specification of the dynamic setting, we assume that changing regime entails a direct cost or benefit. To be precise, we assume that nationalizing the industry (switching from private ownership to state ownership) is associated with a one period loss of c_S goods. This cost is assumed to be exogenous and interpretable as the deadweight loss resulting from a political backlash or international sanctions following nationalization.

Likewise, privatizing the industry results in a temporary boost to government revenues due to the proceeds from selling state firms. We assume that the government makes a take-it or leave-it offer to a measure one of incumbent firms in exchange for the rights to operate in the industry. Competitive bidders drive the offer up to the firm's value and, therefore, the government extracts all the rents. We assume that a fraction $0 \leq \kappa \leq 1$ of these rents are transferred lump-sum to the current workers. The remaining fraction is a loss that can be interpreted as the cost of reorganizing the industry, selling the firms, corruption, and the like.

Under our assumptions, dynamic behavior is relatively easy to characterize in recursive form. Let $V_P(p)$ denote the value for the government at the *end* of a period in which the price is p and the regime ends up being private ownership, and has been in private ownership for at least one period. Likewise, let $V_P^0(p)$ denote the value for the government at the *end* of a period in which the industry is privatized (after having been state owned the previous period) and the price is p. Similar definitions hold for $V_S(p)$, the value in a state ownership regime, and $V_S^0(p)$, the value in a period in which the industry is nationalized.

Then, the function $V_P(p)$ satisfies the Bellman equation

$$V_P(p) = U_P(p) + \beta \int \max\{V_P(p'), V_S^0(p')\} Q(p, dp') \tag{9}$$

where $Q(p, B) = \Pr\{p_{t+1} \in B | p_t = p\}$ is the transition function governing the price process, and p' is next period's price. The interpretation is straightforward: the value of a privatized regime is today's payoff to the average worker, $U_P(p)$, plus the discounted value of tomorrow's option to continue in the privatized regime, $V_P(p')$, or to nationalize the industry, $V_S^0(p')$.

Similarly, the value in a state ownership regime $V_S(p)$ satisfies

$$V_S(p) = U_S(p) + \beta \int \max\{V_P^0(p'), V_S(p')\} Q(p, dp'). \tag{10}$$

In periods of regime change, that is, when the industry is just privatized or just nationalized, the value functions are respectively given by

$$V_P^0(p) = U_P^0(p) + \beta \int \max\{V_P(p'), V_S^0(p')\} Q(p, dp') \tag{11}$$

$$V_S^0(p) = U_S^0(p) + \beta \int \max\{V_P^0(p'), V_S(p')\} Q(p, dp'), \tag{12}$$

where $U_P^0(p)$ and $U_S^0(p)$ denote the static payoffs in the privatization period and nationalization period respectively.

Because nationalization entails a cost c_S, the payoff in a nationalization period is, simply,

$$U_S^0(p) = u\left[\frac{pF(L_S) - c_S}{N}\right],$$

We now describe the payoff in a privatization period, $U_P^0(p)$. To that end, let $W^0(p)$ denote the value of a private firm in the privatization period, and let $W(p)$ denote the value of the firm in subsequent periods. These functions are different because the additional lump-sum transfer at the privatization period modifies the incentives to exert effort.

The function $W(p)$ satisfies the recursive equation

$$W(p) = (1 - \tau)R(p) + \frac{1}{1 + r} \int_\Omega W(p') Q(dp', p),$$

where $\Omega = \{p' : V_P(p') \geq V_S^0(p')\}$ is the set of prices tomorrow for which the industry remains private, and $R(p)$ is the firm's before-dividend-tax profit function. In computing the present discounted value of the firm tomorrow, we are considering only those prices for which the firm will not be nationalized in the next period, Ω.

Likewise, the value of the firm in a privatization period is given by

$$W^0(p) = (1-\tau)R^0(p) + \frac{1}{1+r}\int_\Omega W(p')Q(dp', p),$$

where $R^0(p)$ is the firm's before-dividend-tax profit function at the privatization period.

We obtain the static payoff $U_P^0(p)$ and the profit function $R^0(p)$ by solving the static equilibrium with private ownership including the transfer from selling the firms. This static equilibrium is identical to the one described in section 3.3, except that here the government budget constraint (8) includes an additional source of funds, $\kappa W^0(p)$, raised from selling state firms:

$$pF(N\ell(a_0))\left[\tau(1-\theta)+\theta\right] - \tau N\left[\pi(a_0)y_{H0} + (1-\pi(a_0))y_{L0}\right] + \kappa W^0(p) = T_0 N$$

Once we have the equilibrium allocation, we compute the static payoffs

$$U_P^0(p) = \pi(a_0)u(y_{H0}+T_0) + (1-\pi(a_0))u(y_{L0}+T_0) - \phi(a_0)$$

and

$$R^0(p) = p(1-\theta)F(N\ell(a_0)) - N[\pi(a_0)y_{H0} + (1-\pi(a_0))y_{L0}].$$

Given U_P, U_S, U_P^0, U_S^0, and the law of motion for p, the dynamic equilibrium is given by solutions V_P, V_S, V_P^0, and V_S^0 of the four functional equations (9), (10), (11), and (12). For an interesting range of parameters, the solution is illustrated in Figure 2. The functions V_P and V_S inherit the shapes of U_P and U_S respectively. The figure identifies a trigger price p^* such that:

$$V_P(p^*) = V_S^0(p^*)$$

From (9), p^* is the price at which the government is indifferent between nationalizing a privately owned industry or leaving it in private hands. As long as the price is below p^*, the government refrains from nationalization, while nationalization occurs if the price jumps above p^*.

The figure also identifies another trigger price, p^{**}, such that

$$V_S(p^{**}) = V_P^0(p^{**})$$

From (10), p^{**} is the price at which the government is indifferent between privatizing a state owned sector or not. Hence, if the industry is under state ownership, it will remain in that regime as long as p_t is above p^{**}. Privatization occurs, however, if p_t falls under p^{**}.

In equilibria of the form just described, there is a range of prices $p_t \in (p^{**}, p^*)$ for which the industry could be either in private ownership or state ownership regime depending on the previous history of prices. That is, this model features a form of hysteresis in the sense that the ownership regime in period t depends not only on the current price p_t but also on the history of prices $p_0, p_1, ..., p_{t-1}$ leading to p_t . This is a consequence of the gap in the value functions due to the nationalization costs and privatization benefits represented by c_S and κ.

4.2 Key Implications and Interpretation

In addition to the functional forms used in section 3.5, we assume the following stochastic process for the price,

$$p_t = \bar{p} \exp(z_t),$$

where z_t follows a stationary first order autoregressive process,

$$z_t = \rho z_{t-1} + \varepsilon_t, \quad |\rho| < 1 \text{ and } \varepsilon_t \sim N(0, \sigma^2).$$

Under this assumption, the price p_t is log-normal with a stationary distribution that has mean $E(p_t) = \bar{p} \exp\left(\tilde{\sigma}^2/2\right)$ and variance $Var(p_t) = \bar{p}^2 \left(\exp \tilde{\sigma}^2 - 1\right) \exp \tilde{\sigma}^2$, where $\tilde{\sigma}^2 = \sigma^2/\left(1-\rho^2\right)$ is the variance of the stationary distribution of z_t.[15]

We interpret a period in the model to be one year, and set the parameters that determine the evolution of the price p_t by running a first order autoregression on the logarithm of real yearly crude oil prices.[16] The point estimates of these regressions are $\rho = 0.89$, $\sigma = 0.24$, and $\bar{p} = 54.6$. Thus, the expected value and standard deviation of the invariant distribution of the price p_t are 62.8 and 35.5 respectively.

It remains to set the parameters β, r, κ, and c_S. We choose these parameters (and those common with the static model) to imply privatization and nationalization cycles of similar duration to those observed in the hydrocarbon sector in Bolivia –historically, a state ownership regime in Bolivia lasts between 20 and 25 years while private ownership, between 12 and 15 years. We assume a subjective discount factor of $\beta = 0.95$ and an interest rate of $r = 0.1$. We assume that 50 percent of the resources raised at the privatization period are redistributed to the workers, so that $\kappa = 0.5$. A reasonable value for the nationalization cost c_S is more difficult to choose. Here we simply assume that the nationalization cost is such that if the commodity price is 30 percent of its long-run average value, namely $0.3E(p_t)$, consumption in a state ownership regime is zero. This implies $c_S = 0.3E(p_t)F(L_S)$. For our baseline calibration, the nationalization cost is $c_S = 0.64$, which represent about 31 percent of the value of production at the nationalization price p^*. These parameters are reported in Table 1.

Given the baseline parameters, we can numerically compute the privatization and nationalization trigger prices p^{**} and p^* as well as other interesting implications of the model, such as

[15] The literature is inconclusive regarding the stationarity of oil and mineral prices. Papers that allow for structural breaks tend to find that these prices are stationary, while those that do not allow them find unit roots. See Noguera (2013) for a review and new results. We assume that resource prices are stationary for purposes of tractability. The analysis would become unnecessarily complicated if we assumed a stochastic process without mean reversion. In this, we follow Guriev, Kolotilin, and Sonin (2011) and Stroebel and van Benthem (2013). As noted in the latter paper, a unit root process for resource prices would reinforce the result that nationalization is more likely as prices increase.

[16] Oil prices are average annual prices per barrel of oil, in constant 2008 U.S. Dollars. Adjustment for inflation is obtained using the U.S. consumer price index. The spot oil price correspond to the West Texas Intermediate, as reported by Dow Jones & Company.

the average duration of each regime. To be precise, we define the duration of a state ownership regime as the average number of years for the first time a price starting at $p_t = p^*$ reaches p^{**}. We note, however, that the proposed statistic is a lower bound on the duration of the regime, for the initial price could start at a value above p^*. Likewise, we define the duration of a privately owned regime as the average number of periods for the price to move from p^{**} to p^*. These statistics are computed using Monte Carlo simulations and depend on the model parameters only through the invariant distribution of prices and the thresholds p^* and p^{**}.[17]

In the baseline economy, the industry is state-owned at all prices greater than $p^* = 60.4$ and privately-owned at all prices smaller than $p^{**} = 36.7$. The average duration of a state ownership regime is 22 years and that of a private ownership regime is 14 years.

Further insight on the mechanics is obtained by delving deeper into the dynamics of income inequality. Figure 3 plots the difference of the incomes of highly productive workers and low productivity ones, $y_H - y_L$, as a function of the resource price p, assuming private ownership. The difference widens for an initial range of values of p up to a maximum near $p = 58.7$. Note that nationalization occurs for values of p above $p^* = 60.4$, and that $y_H - y_L$ is still very close to its maximum at this price. Hence the figure indicates that income differences essentially increase with p while the resource is in private hands, and are close to maximal when nationalization occurs.

Figure 4, in turn, shows output, labor supply, and effort as functions of p, assuming again a private regime. Effort increases with p for low values, and then decreases; the graphs of labor and output mirror that of effort. This reflects that providing incentives for effort is increasingly costly as the resource price increases. A higher p means that the average income of workers goes up (because of competition and of transfers); accordingly, inducing high effort requires firms to pay a larger wage differential, due to concave utility. Firms respond to this trade-off by indeed increasing the wage differential (as shown in Figure 3) but also allowing effort to fall

[17] We run 3000 simulations of length 50000, where the initial price is drawn randomly from the invariant distribution of prices. For each simulation we compute the average duration of each regime and next average the results across simulations.

when p increases (except for low values of p, as noted).

Notably, there is no contradiction between the fact that effort falls with p and the view that income inequality increases in a private regime. In fact, figures 3 and 4 reinforce each other in this respect. They show that inequality goes up with p for two reasons: the incomes of high productivity workers increase relative to the incomes of low productivity ones; and the numbers of the former (the highly paid ones) fall relative to the latter, since less effort implies a smaller $\pi(a)$.

Under a private regime, part of the revenue from the resource is appropriated by firm owners in the form of after tax profits. Since the welfare of firm owners is not included as part of the government's objective function, an additional motive for nationalization is the expropriation of such profits and its redistribution towards the workers. To assess this force, Figure 5 shows how income is split between workers and firms in a private regime as the price p changes. The figure shows that the payoffs to firm owners indeed increases with p. But the figure also shows that workers benefit too. In fact, the respective shares are virtually independent of p in the baseline model: firm owners are paid about 16 percent of revenues, workers the rest.

These observations add up to the following. If the resource is in a private regime, increases in the price p imply that the main advantage of the regime, efficient effort provision leading to higher productivity, shrinks (in fact, when p is close to p^* such an advantage becomes very small, as effort becomes close to zero). At the same time, higher p means that wage inequality widens, and also that the amount paid to firm owners, as after tax profits, increases. Hence if p rises sufficiently, that is, if it rises above p^*, it becomes optimal for the government to nationalize the resource, paying the cost c_S. State ownership implies that workers' incomes are equalized and that no revenue is lost to outsiders (potential firm owners). But it has a cost: suboptimal amounts of effort, and hence, aggregate labor supply. This cost is greater when the price p falls away from p^*, as Figure 3 implies. If p falls below p^{**}, it becomes optimal for the government to restore efficiency, even at the cost of increased inequality, by privatizing the resource.

This process is highly nonlinear, and the resulting dynamics depend in a complex way on the parameters of the model. To shed light on the links, we next explore the impact of changing those parameters.

4.3 Comparative Dynamics

Table 3 reports the implications of different parameterizations. The first row of the table reports the threshold prices and duration statistics of the baseline parametrization. Subsequent rows describe the impact of changing the baseline parameters one at a time.

Consider an increase in risk aversion from the baseline $\gamma = 2.5$ to $\gamma = 3$. Both threshold prices decline, the average duration of a state ownership regime increases substantially and that of a privately ownership regime decreases slightly. The intuition for the change in the threshold prices is similar to that in the static model: if the resource is in private hands, higher risk aversion increases the social welfare cost of inequality, thus making nationalization more socially attractive; when the resource is state owned, higher risk aversion reduces the benefits from privatization. To understand the changes in the duration statistics, note that the stationary distribution of prices do not change but the threshold prices are now $p^{**} = 29.4$ and $p^* = 54.1$. Because prices are mean reverting, clearly the time it takes for the price to move from 29.4 to 54.1 will be substantially smaller than the time it will take to go from 54.1 to 29.4 for the simple reason that the average price is above both threshold prices.

The intuition for the changes in threshold prices due to changes in the parameters φ, δ, ν, l_L/l_H, α, τ, θ, and A is similar to that discussed in the static model. These changes together with the observation that the invariant distribution of prices remains the same in all experiments provide intuition for the changes in the duration statistics. Consider, for example, a decrease in the ratio l_H/l_L from 10 to 5 keeping the same average labor supply when effort is zero. This change implies a decline in both threshold prices, with the privatization threshold being just $p^{**} = 25.7$ and the nationalization threshold, $p^* = 51.7$. It is clear that it will take a long time for a mean reverting process with average value of 62.8 to move from 51.7 to 25.7.

This observation explains that the average duration of a state-owned regime is about 54 years. On the other hand, the mean reverting property of the price process implies that the average duration of a private ownership regime is reduced to 13 years.

We now consider changes in the parameters that are specific to the dynamic model. Consider first an increase in the nationalization cost c_S to 0.86.[18] The nationalization threshold p^* increases from 60.4 to 67.8 and the privatization threshold p^{**} decreases from 36.7 to 36.2. It is clear why p^* increases: given a higher nationalization cost, the welfare costs of a privately owned regime, due to wage inequality and a fraction of income paid to firm owners, must be larger before nationalization is called for. This, in turn, implies that p^* increases. In addition, note that the privatization threshold p^{**} also changes even though the nationalization cost is paid only during the period of nationalization. The reason for this change is the indirect negative impact that an increase in c_S has on the value of a private ownership regime due to the possibility of future nationalizations of the industry. In any case, however, changes in c_S have a much larger impact on the nationalization threshold p^* than on the privatization threshold p^{**}. In terms of duration, the increase in p^* and the decrease in p^{**} imply that each regime lasts longer. Indeed, the average duration of a state owned regime increases from 22 years to 25 years, and that of a state privately owned regime 14 to 18 years. Clearly, the duration of the private ownership regime increases substantially more than that of a state-owned regime.

Consider next a change in the privatization benefit κ. Assume that κ declines from 0.5 to 0.25, so that 75 percent of the benefits of privatizing the industry are lost or are used for purposes other than transfers. On a qualitative level, this change has the same impact as an increase in the nationalization cost c_S –both imply a higher loss of resources. The difference is that a drop in κ operates through a change in the value of a private ownership regime at the privatization period while an increase in c_S operates through a change in the value of a state ownership regime at the nationalization period. Thus, p^{**} decreases, p^* increases, and the average duration of each regime increases as well.

[18]The cost $c_S = 0.86$ implies that about 37 percent of the value of output is used to pay the costs associated with nationalizating the industry when the commodity price is $p_t = p^*$.

The last two experiments involve perturbing the persistence and the volatility of the stochastic process z_t. Because these changes affect the invariant distribution of p_t, the interpretation of the results must be taken with caution. In all cases, we adjust $\bar{p}$ so that the invariant distribution of p_t has always the same mean of $E(p_t) = 62.8$. However, there are not enough parameters to simultaneously maintain the mean and standard deviation of p_t constant while changing the persistence of the process. Thus, keeping the mean constant, changes in the persistence parameter ρ necessarily involves changes in the volatility of p_t.

Consider a mean preserving change in the parameter ρ. A decline in persistence from 0.89 to 0.5 increases the privatization threshold p^{**} from 36.7 to 40.5 and the nationalization threshold p^{*} from 60.4 to 63.4.[19] In addition, the duration of both regime declines. Intuitively, the less persistent is the price, the more often the price will cross the thresholds p^{*} and p^{**}, leading to shorter regime durations. When ρ declines, however, the long-run variance of the price declines as well which, in turn, could lead to longer regime durations. In our parameterization, the former effect dominates the latter.

The last experiment consists of a mean preserving spread of the price distribution. We increase the volatility σ from 0.24 to 0.48 adjusting $\bar{p}$ so that the expected long-run price remains constant. Both threshold prices decline, the duration of state ownership regime declines substantially, and that of private ownership does not change. Intuition suggests that duration of a privately owned regime should decrease as well. In effect, if the model is calibrated on a monthly basis we do observe a decline of a few months in the duration of a privately owned regime. The yearly frequency of the model is too coarse to capture the shorter duration.

A related way to understand the propagation mechanism embedded in the model is to compare the stochastic properties of the endogenous variables with that of the price. Figure 6 illustrates this point by focusing on a simple measure of persistence. The left panel displays the ratio of the autocorrelation function of output to that of the price –the relative autocorrelation function– for the baseline parameterization of the model (solid circled line). The second

[19] Neither p^{*} nor p^{**}, however, move monotonically with changes in ρ.

(dashed) line corresponds to a model where the industry is always private and there is no possibility of changing regime.[20] The right panel of the figure displays an analogous chart for effort. Lags for which the relative autocorrelation function is above (below) one are lags for which the corresponding endogenous variable displays more (less) persistence than the price. For example, output displays more persistence than the price at lags one through nine and less persistence than the price at longer lags. The difference is significant: while output is almost three percentage points more persistent than the price at the third lag, it is almost eight percentage points less persistent than the price at the 30th lag. The difference is even starker if we focus on effort: at the 30th lag, effort is eleven percentage points less persistent than the price. Similar results hold for the rest of the endogenous variables.

The endogenous variables have different persistence than the price for two reasons. First, the model delivers policy functions that are non-linear functions of the price. Non-affine transformations of a stochastic process do not preserve the autocorrelation function. Second, and more importantly, the endogenous choice between private and national regimes induces more persistence at shorter lags and less persistence at longer lags. To understand this point, compare the difference between the relative autocorrelation function of the baseline model with that of the model with only a private regime. The latter differs from 1 only due to the non-linearity of the policy functions. The difference between the models with and without regime change reflects the additional propagation mechanism induced by the privatization-nationalization choice.

The endogenous variables in the model with only private firms are less persistent than the price at all lags, while those in the model with regime change are more persistent than the price at short lags. The higher persistence at short lags in the model with regime change is due to the high persistence in the national regime. Effort, labor, and output are constant in the national regime. On the other hand, the model with only private firms is more persistent than the model with regime change at longer lags because the shifts in regime, whose likelihood

[20] We run 250 simulations of length 100,000, where the initial price is drawn randomly from the invariant distribution of prices. We compute the sample autocorrelation function for each simulation and next average the results across simulations.

increases with lag length, induce large changes in the endogenous variables. Moreover, note that the relative autocorrelation functions cross at the 14th lag, consistent with the observation that, on average, there are regime shifts every 14 years (from private to national) and every 22 years (from national to private).

4.4 Discussion

It is worth stressing the ways in which the model is consistent with the set of four observations identified in our empirical review in section 2.

As to *Observation 1*, the dynamic model clearly stresses the repeated, cyclical nature of privatization - nationalization episodes. In the model, the choice between public versus private ownership reflects an underlying equity-efficiency tradeoff, which is affected in a natural way by the cyclical fluctuations of the natural resource price. Moreover, while we have modeled a single country in isolation, note that because the resource price is presumably common to many producer countries, the model is consistent with the observation that these episodes often involve multiple countries.

With respect to *Observation 2*, our analysis is not necessarily restricted to a specific sector, but it does focus on factors that are likely to be more prevalent in natural resource sectors than in alternative ones. The model, in particular, assigns a key role to the movements in the international price of the national resource. Furthermore, in the model the exploitation of the resource is the main (indeed the only) productive activity of the domestic economy. These two features are typical of economies based on the exploitation and export of natural resources.

Observation 3 is reproduced by the model, as its calibrated versions imply that nationalizations happen when the price of the domestic resource is high. This occurs because, when prices are high, concerns about equity become relatively more pressing. Privatizations occur in our model when prices fall below a threshold value. If prices subsequently increase, the resulting windfalls are partly appropriated by the private buyers, until the price increase triggers nationalization.

Moreover, the fact that private owners can benefit from price bonanzas in a privatized regime is necessary to justify the price they paid for the resource. In our model private owners do not appropriate supra-normal profits, so that their profitability when prices are high serves only to compensate them for low or negative profits when prices are low.

In the model, nationalization occurs when inequality across workers becomes relatively more important for social welfare. At the same time, nationalization happens as profits of the privately owned firm are at their highest. Hence, the model can account for *Observation 4*. But note, again, that in the model private owners do make normal profits even after accounting for the possibility of expropriation. Indeed, the price at which the owners acquire the resource in the first place takes into account the fact that nationalization will occur when the price increases sufficiently. Also, note that in our model inequality lowers social welfare because of risk aversion. Increases in the risk aversion coefficient may therefore capture a stronger concern for inequality. Given this interpretation, the model delivers the prediction that increased risk aversion makes state ownership and nationalizations more likely.

5 Concluding Remarks

The theory suggests several policy implications, some direct, others less so. Our model highlights that cycles of nationalization and privatization are, ultimately, linked to the government's inability, under a nationalized regime, not to redistribute income among domestic workers. In this sense, the model implies that institutional improvements may help eliminating privatization - nationalization cycles, but only to the extent that such reforms enhance the ability of the government to commit in advance to a (non-) redistributive policy. Institutional reforms to increase transparency and accountability, or to strengthen property rights, are examples in this regard.

A less obvious suggestion for policy relates to the possible impact of financial reform on privatization-nationalization cycles. An implicit assumption underlying our theory is that,

in a privatized regime, workers cannot pool wage income risks with each other. This is a natural assumption and is consistent with the view that countries that display privatization-nationalization cycles are likely to suffer from financial frictions as well. In this regard, we can reinterpret our analysis of changes in risk aversion parameters as attempts to capture what would happen if financial imperfections were less binding. The theory would then say that financial reforms would reduce the incentives for nationalization.

Admittedly, though, more research appears to be warranted to flesh out these and other policy implications of the theory. It is likely that some of the elements that we have taken as exogenous in our model, such as the structure of capital markets or the costs of nationalization, are related to policy instruments and institutions. If so, the analysis of this paper could be reinterpreted as tracing the impact of changes in those policies and institutions. Clearly, however, making such a reinterpretation would require a more detailed specification of the fundamentals of the economy.

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A Appendix

A.1 Proofs

Proof of Lemma 1: We proceed by contradiction. Suppose $\{y_H^o, y_L^o, a^o, n^o\}$ is optimal but

$$\pi(a^o)u(y_H^o + T) + (1 - \pi(a^o))u(y_L^o + T) - \phi(a^o) > U^*.$$

We propose a feasible plan that induces the worker to supply the same effort a^o but increases the firm's profits. Because the proposed plan is incentive compatible, we can write the above inequality as

$$\pi(a^o)\gamma(a^o) + u(y_L^o + T) - \phi(a^o) > U^*.$$

Because u is continuous and increasing, there is an $\hat{\epsilon} > 0$ such that $\pi(a^o)\gamma(a^o) + u(y_L^o - \hat{\epsilon} + T) - \phi(a^o) > U^*$. Consider now the plan $\{\hat{y}_H, \hat{y}_L, a^o, n^o\}$, where $\hat{y}_L = y_L^o - \hat{\epsilon}$ and $\hat{y}_H$ solve $u(\hat{y}_H + T) = u(\hat{y}_L + T) + \gamma(a^o)$. Clearly, $\hat{y}_L < y_L^o$ and $\hat{y}_H < y_H^o$. The plan $\{\hat{y}_H, \hat{y}_L, a^o, n^o\}$ is incentive compatible, satisfies the IR constraint, and increases the firm's profits. Hence, $\{y_H^o, y_L^o, a^o, n^o\}$ cannot be optimal and the IR must bind.

Proof of Lemma 2: As in Holmstrom (1979), we proceed by contradiction. Suppose $\eta \leq 0$. Using $\gamma'(a) > 0$ and $\eta\gamma'(a) \leq 0$, the optimal effort choice implies

$$n\pi'(a)\left[p(1-\theta)F'(n\ell(a))(l_H - l_L) + y_L - y_H\right] \leq 0. \tag{A1}$$

The first order conditions (5) and (6), together with $\eta \leq 0$ give

$$\frac{n}{u'(y_H + T)} = \lambda + \frac{\eta}{\pi(a)} \leq \lambda - \frac{\eta}{1 - \pi(a)} = \frac{n}{u'(y_L + T)}.$$

The concavity of $u(c)$ implies $y_L \geq y_H$. Thus,

$$n\pi'(a)\left[p(1-\theta)F'(n\ell(a))(l_H - l_L) + y_L - y_H\right] \geq n\pi'(a)p(1-\theta)F'(n\ell(a))(l_H - l_L) > 0.$$

This result contradicts (A1). Therefore, $\eta > 0$.

Proof of Corollary : Rearranging (5) and (6), and using $\eta > 0$ gives $u'(y_H + T) < u'(y_L + T)$. The concavity of $u(c)$ implies $y_H > y_L$.

Proof of Lemma 3: The constrained-efficient allocation solves

$$\max_{a, y_H, y_L} N\left[\pi(a)u(y_H) + (1 - \pi(a))u(y_L) - \phi(a)\right]$$

subject to the IR and IC constraints

$$\begin{aligned} pF\left[N\left(\pi\left(a\right)l_H+\left(1-\pi\left(a\right)\right)l_L\right)\right]-N\left[\pi\left(a\right)y_H+\left(1-\pi\left(a\right)\right)y_L\right] &= 0 \\ u\left(y_H\right)-u\left(y_L\right)-\gamma(a) &= 0, \end{aligned}$$

to which we attach the multipliers N/λ and $\eta N/\lambda$, respectively. The first order conditions with respect to y_H, y_L, and a, can be written as

$$\begin{aligned} \frac{N}{u'\left(y_H\right)} &= \lambda+\frac{\eta}{\pi\left(a\right)} \\ \frac{N}{u'\left(y_L\right)} &= \lambda-\frac{\eta}{1-\pi\left(a\right)} \end{aligned}$$

$$N\pi'\left(a\right)\left\{pF'\left[N\ell(a)\right]\left(l_H-l_L\right)-\left(y_H-y_L\right)\right\}-\eta\gamma'\left(a\right)=0.$$

These conditions and the constraints determine the constrained-efficient allocation $\{y_H^e, y_L^e, a^e, \lambda^e, \eta^e\}$.

Consider now the private ownership regime. Let $\tilde{y}_H^* = y_H^* + T^*$ and $\tilde{y}_L^* = y_L^* + T^*$, set $\theta = 0$ and let $\tau \to 1$. Then, the equilibrium allocation of the private ownership regime solves

$$\begin{aligned} u\left(\tilde{y}_H^*\right)-u\left(\tilde{y}_L^*\right)-\gamma(a^*) &= 0 \\ N/u'(\tilde{y}_H^*)-\left[\lambda^*+\eta^*/\pi(a^*)\right] &= 0 \\ N/u'(\tilde{y}_L^*)-\left[\lambda^*-\eta^*/\left(1-\pi(a^*)\right)\right] &= 0 \\ N\pi'(a^*)\left[pF'(N\ell(a^*))(l_H-l_L)-(\tilde{y}_H^*-\tilde{y}_L^*)\right]-\eta^*\gamma'(a^*) &= 0 \\ pF(N\ell(a^*))-N\left[\pi(a^*)\tilde{y}_H^*+(1-\pi(a^*))\tilde{y}_L^*\right] &= 0 \\ pF'(N\ell(a^*))\ell(a^*)-\left[\pi(a^*)\tilde{y}_H^*+(1-\pi(a^*))\tilde{y}_L^*\right]+T^* &= 0. \end{aligned}$$

The first five equations coincide with those of the constrained-efficient allocation and the last condition pins down the equilibrium transfer T^*. Therefore, $\{\tilde{y}_H^*, \tilde{y}_L^*, a^*\} = \{y_H^e, y_L^e, a^e\}$.

A.2 Computation of the static equilibrium under private ownership

We simplify the system (3 - 8) as follows. We write the payments y_H and y_L as a function of T, λ, and η by rewriting equations (5) and (6) as

$$y_H(T,\lambda,\eta)=\left(u'\right)^{-1}\left[\frac{N}{\lambda+\eta/\pi(a)}\right]-T$$

$$y_L(T,\lambda,\eta)=\left(u'\right)^{-1}\left[\frac{N}{\lambda-\eta/\left(1-\pi(a)\right)}\right]-T$$

Replacing these expressions into the remaining equations gives the following system of four equations in four unknowns,

$$\begin{aligned}
u(y_H(T,\lambda,\eta)+T) - u(y_L(T,\lambda,\eta)+T) - \gamma(a) &= 0 \\
pF'(N\ell(a))\ell(a) - \pi(a)y_H(T,\lambda,\eta) - (1-\pi(a))y_L(T,\lambda,\eta) &= 0 \\
N\pi'(a)\left[pF'(N\ell(a))(l_H - l_L) + y_L(T,\lambda,\eta) - y_H(T,\lambda,\eta))\right] - \eta\gamma'(a) &= 0 \\
pF(N\ell(a))\left[\tau(1-\theta)+\theta\right] - \tau N\left[\pi(a)y_H(T,\lambda,\eta) + (1-\pi(a))y_L(T,\lambda,\eta)\right] - TN &= 0.
\end{aligned}$$

We solve this system of equations on a grid of prices $\{p_1, p_2, ..., p_M\}$.

A.3 Computation of the dynamic model

Because there is a one to one mapping between p_t and z_t, we use z_t as our state variable. We guess that the privatization region is an interval of the form $\Omega = (-\infty, z^*]$ and solve the model under this assumption. We then check that all our experiments satisfy this property.

We use the following algorithm to solve the model

1. Find the functions $U_P(z)$, $R(z)$, $U_S(z)$, and $U_S^0(z)$ on a grid of points and linearly interpolate their values at each z not on the grid;
2. Choose a grid of points $\mathcal{Z} = \{z_i\}_{i=1}^M$;
3. Choose initial guesses $V_P(z;0)$, $V_S(z;0)$, $V_0^p(z;0)$, and $V_S^0(z;0)$ for each $z \in \mathcal{Z}$. For values of z not in $\mathcal{Z}$, we use linear interpolation. Set `j=0`.
   (a) Find the nationalization threshold z^* that solves $V_P(z^*;j) = V_S^0(z^*;j)$.
   (b) Given z^*, iterate on the following functional equation to obtain the firm value $W(z)$ at each grid point $z \in \mathcal{Z}$

$$W(z) = (1-\tau)R(z) + \frac{1}{1+r}\int_{-\infty}^{z^*} W(z')Q(dz', z) \text{ for all } z \in \mathcal{Z}.$$

   We evaluate the integral using Gauss-Hermite quadrature.
   (c) Given $W(z)$, find $U_P^0(z)$ and $R^0(z)$ by solving the static equilibrium at the privatization period at each $z \in \mathcal{Z}$.
   (d) Given $U_P^0(z)$, $R^0(z)$, and the guess $V_P(z;j)$, $V_S(z;j)$, $V_P^0(z;j)$, and $V_S^0(z;j)$, update

the value functions at each grid point $z \in \mathcal{Z}$ using the Bellman equations

$$\begin{aligned}
V_P(z; j+1) &= U_P(z) + \beta \int_{-\infty}^{+\infty} \max\left\{V_P(z'; j); V_S^0(z'; j)\right\} Q(dz', z) \\
V_S(z; j+1) &= U_S(z) + \beta \int_{-\infty}^{+\infty} \max\left\{V_P^0(z'; j); V_S(z'; j)\right\} Q(dz', z) \\
V_P^0(z; j+1) &= U_P^0(z) + \beta \int_{-\infty}^{+\infty} \max\left\{V_P(z'; j); V_S^0(z'; j)\right\} Q(dz', z) \\
V_S^0(z; j+1) &= U_S^0(z) + \beta \int_{-\infty}^{+\infty} \max\left\{V_P^0(z'; j); V_S(z'; j)\right\} Q(dz', z).
\end{aligned}$$

We evaluate the integrals using Gauss-Hermite quadrature.

(e) If value functions are converged, stop; if they are not, set `j=j+1` and return to (a) using the obtained functions as the new guess.

Table 1. Baseline Parameters

Symbol	*Description*	*Value*
A	Productivity	0.15
α	Labor exponent (technology)	0.66
γ	Coefficient of absolute risk aversion	2.5
φ	Cost of effort parameter	1
δ	Probability of success parameter	0.99
ν	Probability of success parameter	2
l_H	High labor endowment	1
l_L	Low labor endowment	0.1
τ	Dividend Tax	0.30
θ	Sales Tax	0.30
Additional parameters of the dynamic model		
ρ	Persistence of log-price	0.89
σ	Standard deviation of log-price	0.24
$\bar{p}$	Parameter in price evolution	54.6
β	Discount factor	0.95
r	Interest rate	0.10
c_S	Nationalization cost (level)	0.64
κ	Privatization benefit (fraction)	0.50

Table 2: Static Model

Symbol	*Description*	*Value*	p^*
–	Baseline Economy	–	40.1
γ	Risk Aversion	2	53.6
		3	31.5
φ	Effort parameter	0.5	48.6
		1.5	35.1
δ	Probability of success parameter	0.9	6.9
ν	Probability of success parameter	1.5	32.9
		2.5	45.4
l_H/l_L	Ratio of labor endowments	5	27.0
		20	49.4
α	Labor exponent in technology	0.5	17.8
		0.75	55.8
τ	Dividend tax	0.2	37.9
		0.4	42.6
θ	Sales tax	0.2	37.9
		0.4	42.3

Table 3: Dynamic Model

Symbol	*Description*	*Value*	*Thresholds*		*Average Duration of Regime*	
			p^{**}	p^{*}	*State-owned*	*Private*
–	Baseline Economy	–	36.7	60.4	22	14
γ	Risk Aversion	2	48.3	70.4	13	16
		3	29.4	54.1	38	13
φ	Effort parameter	0.5	44.2	66.9	15	15
		1.5	32.4	56.7	30	13
δ	Prob. of success parameter	0.9	18.5	45.6	166	13
ν	Prob. of success parameter	1.5	30.6	55.2	35	13
		2.5	41.5	64.6	16	14
l_H/l_L	Ratio of labor endowments	5	25.7	51.7	54	13
		20	45.2	67.6	14	15
α	Labor exponent (techn.)	0.5	17.6	42.3	200	12
		0.75	50.0	74.3	13	17
τ	Dividend tax	0.2	34.8	57.7	25	13
		0.4	38.7	63.4	21	14
θ	Sales tax	0.2	34.9	57.8	26	13
		0.4	38.6	63.4	20	15
A	Productivity	0.1	53.4	75.0	10	16
		0.2	28.1	53.0	43	13
c_S	Nationalization cost	0.43	37.4	52.6	19	10
		0.86	36.2	67.8	25	18
κ	Privatization benefit	0.25	36.4	62.4	23	15
		0.75	37.0	59.5	22	13
ρ	Persistence of shock	0.5	40.5	63.4	19	5
	(mean preserving)	0.95	35.7	59.6	25	24
σ	Volatility of shock	0.12	38.1	58.2	98	14
	(mean preserving)	0.48	31.2	58.0	11	14

Figure 1: Optimal regime choice in static model

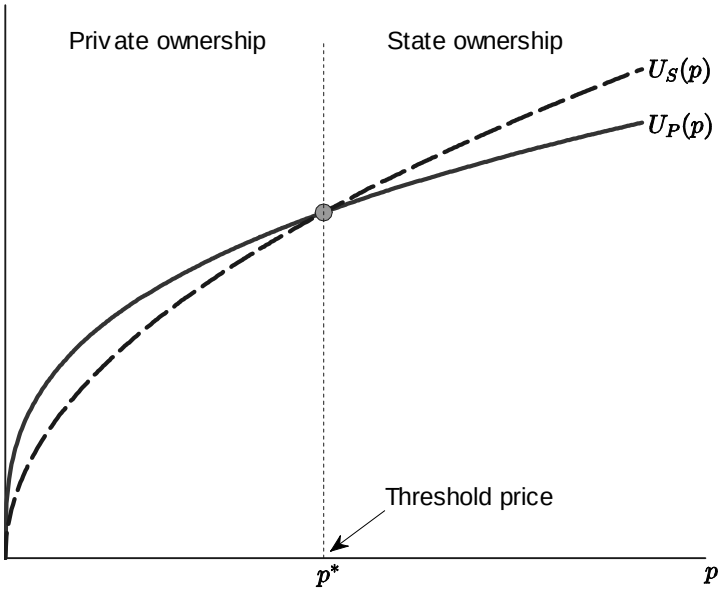

Figure 2: Optimal regime choice in dynamic model

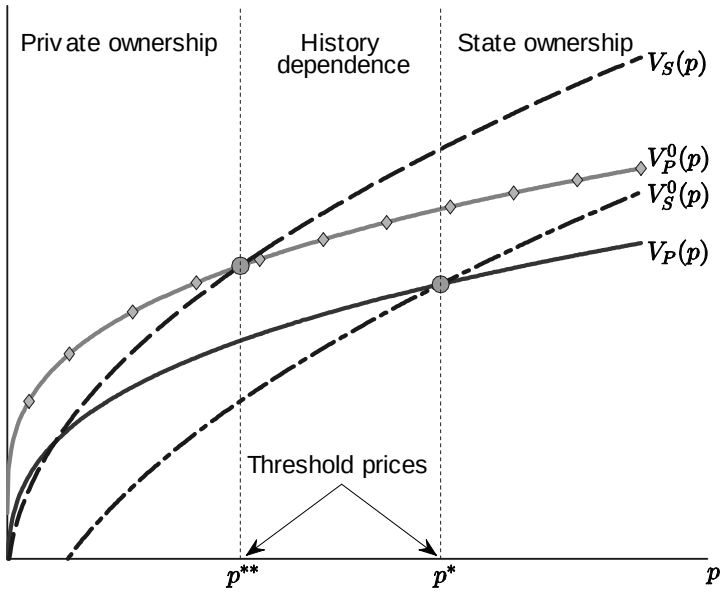

Figure 3: Labor income difference under private regime

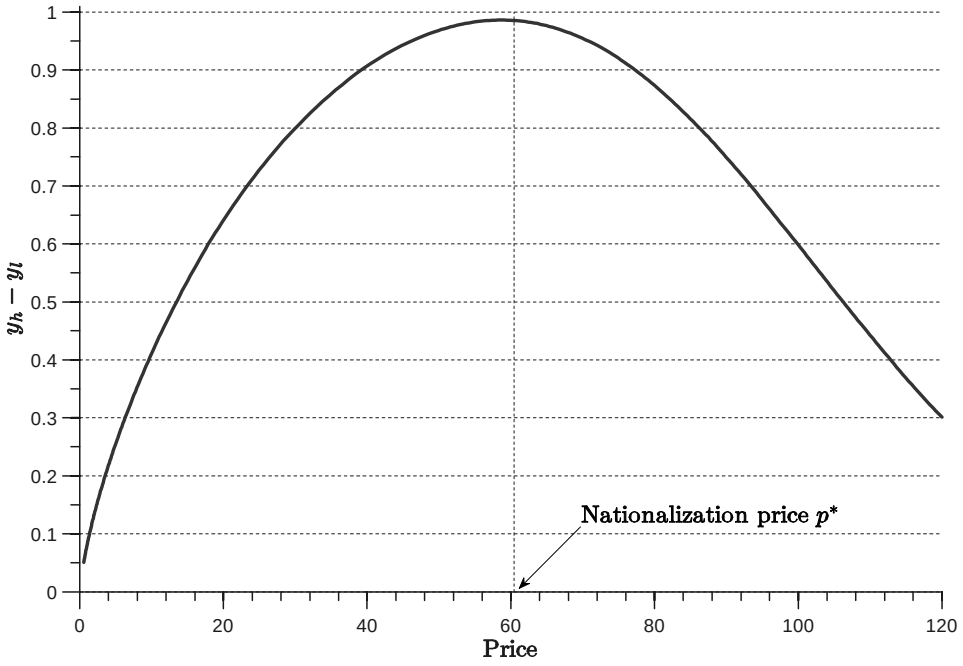

Figure 4: Effort, aggregate labor, and output under private regime

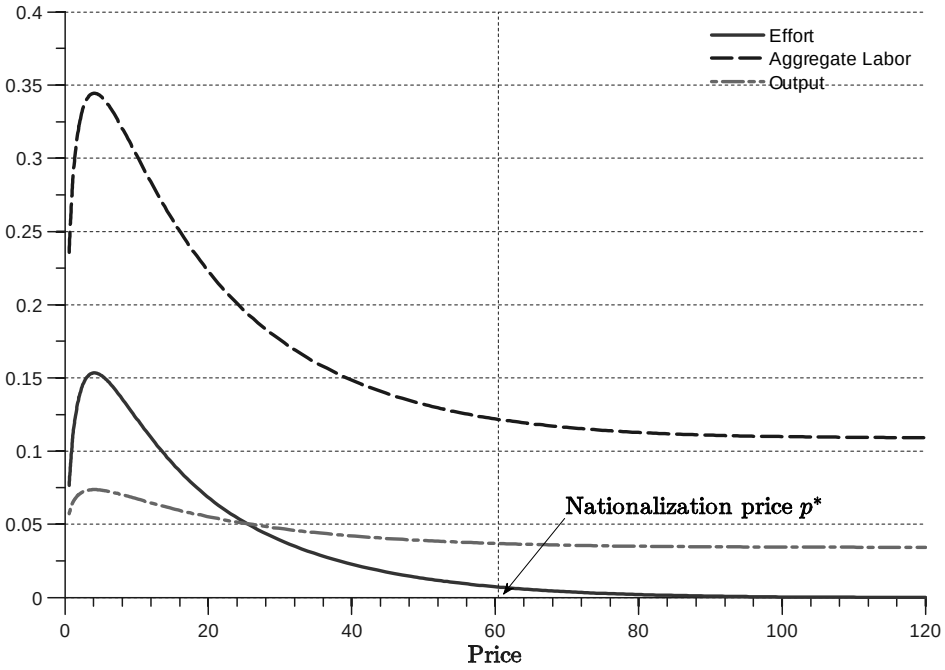

Figure 5: Distribution of aggregate income under private regime

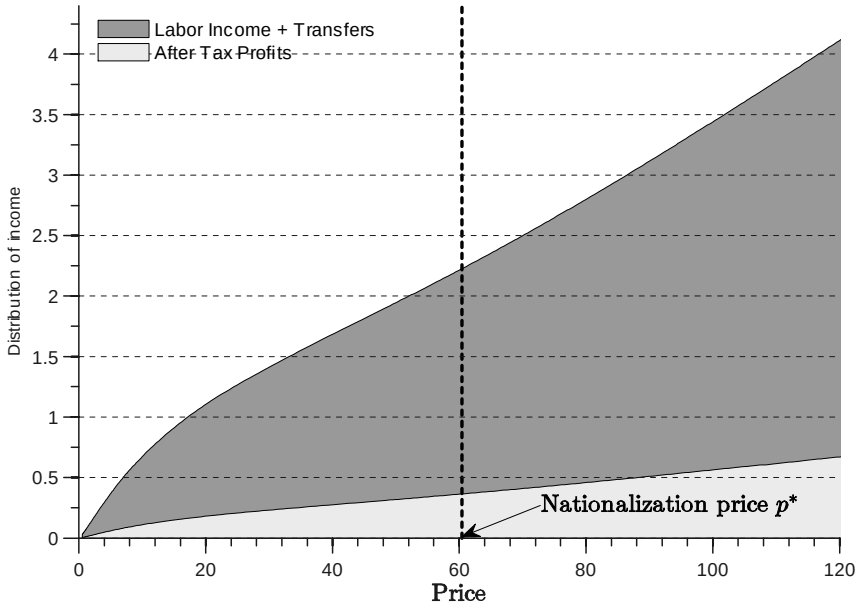

Figure 6: Persistence of output and effort