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Political institutions and the governmental burden on businesses

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Political Institutions and the Governmental Burden on Business

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Political Institutions and the Governmental Burden on Businesses

by

Ruiqing Zhong and Weifeng Zhong*

March 27, 2018

Businesses are "burdened" by government through corporate taxes and bureaucratic procedures. We interpret these two channels as tools for raising revenues and study, theoretically and empirically, how different political institutions rely on these tools. We establish two stylized facts: The degree of democracy has inverted-U relationships with both the bureaucratic and tax burdens. We match these facts with a dynamic political-economic model of fiscal policy where revenues are raised through the burden on businesses and the returns to public capital, and where the degree of democracy is modeled as the limit on the appropriation of capital by misbehaving politicians.

Keywords: bureaucracy, taxation, fiscal policy, democracy, autocracy

JEL classification: E6, H1, H2, P1

1 Introduction

Conventional wisdom has held that political freedom goes hand in hand with economic freedom (e.g., von Hayek, 1944; Friedman, 1962; Olson, 1993). More recently, Djankov et al. (2002) examine the bureaucratic procedures across countries for starting a business and find that democracy is associated with lighter bureaucratic burden. However, some of the most business-friendly economies in recent decades are autocracies (Singapore, Qatar, United Arab Emirates, etc. — see the Global Entrepreneurship and Development Index). Are these examples just outliers? Or, is the conventional wisdom incorrect?

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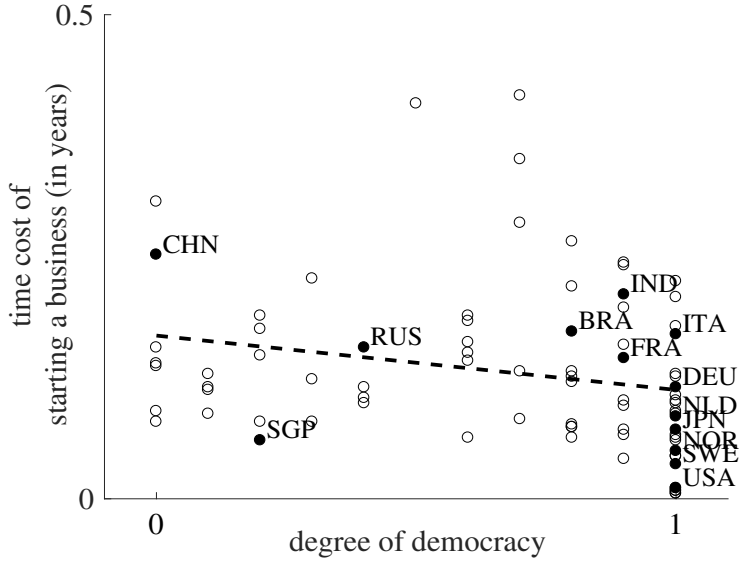
We start by examining the relationship between political institutions and the burden government imposes on businesses. A government can burden businesses through at least two channels: cumbersome bureaucratic procedures that enrich bureaucrats, and high corporate taxes. Both burdens are interpreted in this paper as tools for raising revenues.[1] We first update the analysis in Djankov et al. (2002) of bureaucratic procedures and, with a richer dataset, identify a previously-unnoticed inverted-U relationship between the bureaucratic burden and the degree of democracy (see Figures 1 and 2).[2]

Figure 1
Bureaucratic burden on businesses in 83 countries, 1999.



Source: *Polity IV*, Djankov et al. (2002).

Second, we plot data on the effective corporate tax rate across countries (measured by the effective corporate income tax as percentage of profits) against the degree of democracy. The plot displays another inverted-U relationship (see Figure 3).

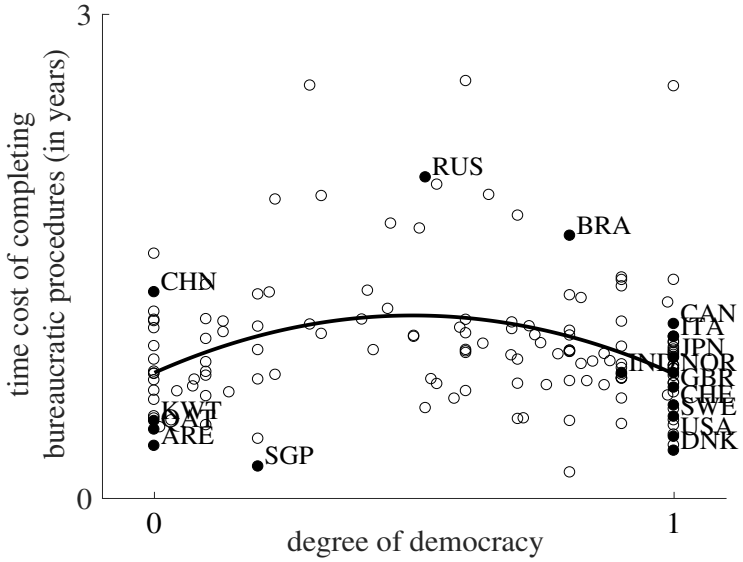
To match the two stylized facts, we develop a dynamic political-economic model of fiscal policy in which the key revenue sources are: (1) distortionary capital taxation, representing *both* the bureaucratic and tax burdens in the data; and (2) public capital, acquired from the private sector efficiently.

In the model, a welfare-maximizing planner chooses the fiscal policy. The chosen policy, however, may not be carried out by a self-interested politician. In each period, instead of carrying out the policy the politician can misbehave, which may result in removal from office by citizens. The politician's misbehavior is formalized as the

[1] Albeit less explicit than taxation, bureaucracy is seen as a mechanism for politicians and bureaucrats to extract resources from the private sector (De Soto, 1989; Shleifer and Vishny, 1998).

[2] See Subsection A.1 for details about the empirical findings in the paper.

Figure 2
Bureaucratic burden on businesses in 152 countries, 2005-2014.



Source: *Polity IV*, World Bank's *Doing Business*.

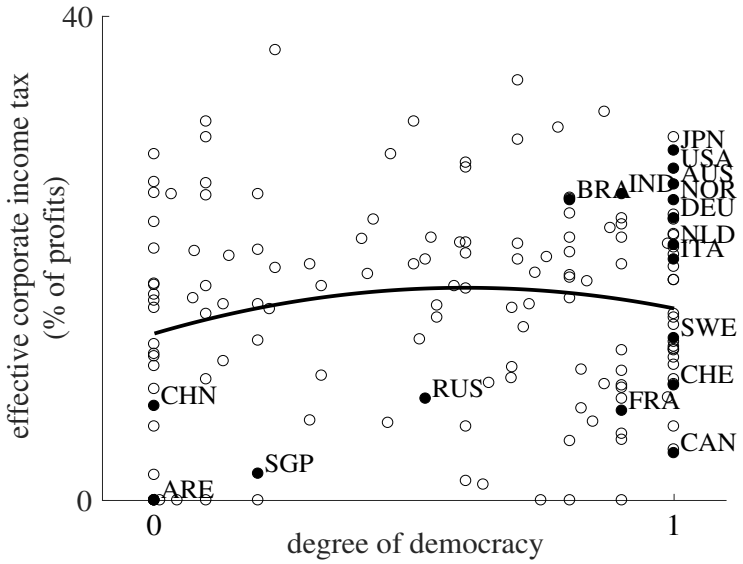
appropriation of a fraction of public capital and a fraction of private capital. In practice, appropriating public capital might mean "privatizing" state-owned enterprises and self-dealing the privatization proceeds, and appropriating private capital might mean incriminating entrepreneurs and confiscating their assets. Due to the politician's option of misbehavior, the planner has to provide the politician with enough office perks, so that the politician will "behave."

This approach with a social planner is in the spirit of the optimal taxation literature. In the model, we stay agnostic about who the planner and the politician are. In reality, one can think of public officeholders as playing dual roles. On one hand, the officeholder values personal consumption and, therefore, acts like the self-interested politician. On the other hand, there are certain societal goals associated with the public office — under democracy *or autocracy* — which the officeholder is expected to fulfill to some extent. In the latter sense, the officeholder acts like the benevolent planner.

The degree of democracy is considered exogenous and modeled through the politician's misbehavior. We say that the degree of democracy is higher if the fractions of public and private capital a misbehaving politician can appropriate are smaller. In a more democratic system, therefore, politicians are more accountable because less harm would be done to the economy before a misbehaving politician is removed from office. In practice, a more accountable system might mean that it is less costly for citizens to punish a misbehaving politician, or that it takes less time to have the politician removed from office.

The key component of the model that allows us to match the stylized facts is the presence of public capital as an alternative revenue source. This revenue source is more

Figure 3
Tax burden on businesses in 155 countries, 2013-2014.



Source: *Polity IV*, World Bank's *Doing Business*.

efficient compared to (distortionary) capital taxation but politically costly because it is susceptible to appropriation. As we show in the model, the case for capital tax to be increasing in the degree of democracy exists when the political cost of public capital exceeds the "economic cost" of capital taxation.

In equilibrium, a higher degree of democracy has two effects on the fiscal policy. One is a "level" effect. A more democratic system, through lowering the fractions of public and private capital a misbehaving politician can appropriate, worsens the politician's outside option and, accordingly, lowers the *level* of office perks necessary to keep the politician in line. Therefore, the planner can afford to reduce both public capital and capital tax in revenue-raising — *the level effect*.

The other is a "substitution" effect. From the planner's perspective, the degree of democracy affects how vulnerable to appropriation public capital is relative to private capital. This, in turn, leads to an incentive to substitute public capital with capital taxation in revenue-raising, or vice versa — *the substitution effect*. An important scenario is when a higher degree of democracy improves the protection of private capital more quickly compared the protection of public capital. The idea is that public capital, due to the lack of monitoring by citizens, is easier to be appropriated by the politician. In this case, as the political system becomes more democratic, public capital as an economically efficient revenue source becomes politically more costly compared to capital taxation. The substitution effect, therefore, suggests higher capital tax as the degree of democracy increases — opposite to the level effect.

We show that, under standard functional form assumptions, the substitution effect dominates the level effect if a higher degree of democracy improves the protection of

private capital sufficiently more quickly than that of public capital. That is, a more democratic system can lead to a smaller amount of public capital and a higher capital tax.

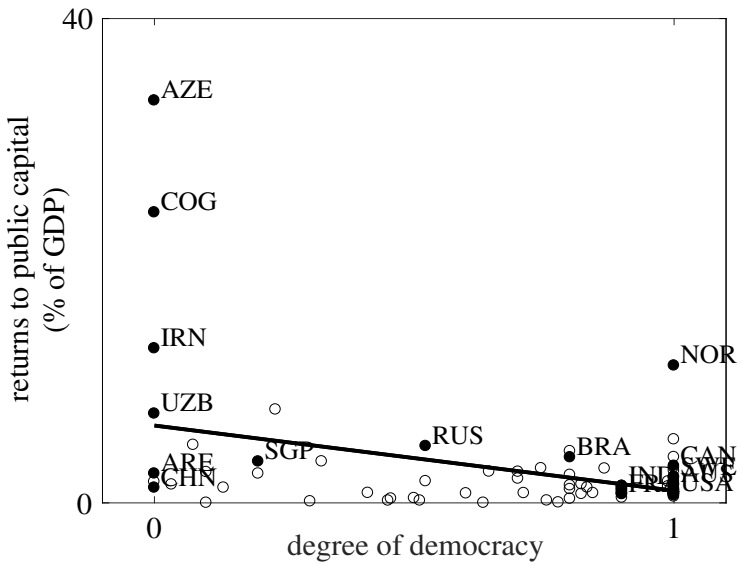
In a numerical example, we show that, when the substitution effect dominates, the model can match the stylized facts established previously. The key feature of the example is: (1) when the degree of democracy is relatively high, public capital is so costly that it is kept at the minimum (zero); (2) when the degree of democracy is relatively low, public capital becomes less costly and, hence, strictly positive.

In countries relatively more democratic — case (1) — the substitution effect is *absent* because public capital is kept at zero. The level effect is the only effect present, so a higher degree of democracy leads to a lower capital tax. The prediction, therefore, is that the governmental burden on businesses mainly comes in the form of bureaucracy or taxation, and such burden is decreasing in the degree of democracy (i.e., the right side of the inverted-U shape).

In countries relatively less democratic — case (2) — *both* the level and substitution effects are present. Since the substitution effect dominates, the prediction is that, as the degree of democracy increases, the bureaucratic and tax burdens become heavier, substituting public capital in revenue-raising (i.e., the left side of the inverted-U shape).

Besides matching the inverted-U shape for the two burdens, the model predicts that public capital decreases in the degree of democracy. In Figure 4, it is shown as a third stylized fact that the returns to public capital as a percentage of GDP is lower in more democratic countries — consistent with the prediction.

Figure 4
Returns to public capital in 89 countries, 2005-2012.



Source: *Polity IV*, IMF's *Government Finance Statistics*, World Bank's *World Development Indicators*.

China provides an interesting example.[3] In contemporary China, about 20% of government revenues are raised by land sales to industrialists and developers.[4] In fact, autocratic governments relying on land sales in revenue-raising during the industrialization process is hardly new in economic history. For about a century since the late 1530s, a significant fraction of crown revenues in England came from selling land seized from the Catholic Church of England by Henry VIII. When Mexico was ruled by Porfirio Díaz, the land seized from the indigenous people during 1880s served as a lucrative revenue source as well. In both examples, the economies are considered business-friendly by economic historians.[5] Therefore, the evidence seems to confirm the model's prediction about public capital.

The rest of the paper is organized as follows. The related literature is reviewed in the next subsection. Section 2 sets up the baseline model. The problem of finding the equilibrium fiscal policy is formulated in Section 3. In Section 4, we examine the two effects of democracy, and we derive results that can match the stylized facts. Section 5 extents the baseline model by allowing more fiscal instruments. Section 6 concludes. The details about the empirical findings and the proofs of theoretical results are relegated to the Appendix.

1.1 Related Literature

The governmental burden on businesses falls into economic institutions which, broadly defined in the literature, include friendliness of business environment, protection of property rights, enforcement of contracts, provision of public services, etc.

The belief that liberties in the political and economic spheres are associated with each other is long-standing. Most recently, Acemoglu and Robinson (2012) forcefully make this point. They argue that "inclusive economic institutions" — institutions that encourage economic activities — are not sustainable in the long run without "inclusive political institutions" of which democracy is an important component.

However, the empirical work establishing this relationship starts only recently, and the findings are rather clouded.[6] For example, Clague et al. (1996) emphasize that the quality of economic institutions varies *within* the degree of democracy so much that empirical tests that establish the relationship between the quality of economic institutions and the degree of democracy are bound to be misspecified. Their empirical test does find a positive correlation. However, they also find that, for countries in their sample that moved from one regime type to another, the quality of economic

[3]See Subsection A.1.4 for more details.

[4]Technically, being sold are the land-use rights for a period of 40-70 years, depending on the usage. The revenue share is calculated from *China Statistical Yearbook* and *China Land and Resources Statistics Yearbook*.

[5]See Nef (1940) for the case of England and Katz (1991) for the case of Mexico.

[6]This literature is relatively small compared to the volumes of work that has established a strong and robust causal relationship between the quality of economic institutions and economic outcomes. See, most notably, Hall and Jones (1999), Acemoglu, Johnson, and Robinson (2001), Easterly and Levine (2003), and Rodrik, Subramanian, and Trebbi (2004) .

institutions was *higher* while they were autocracies than while they were democracies. Likewise, Cheibub (1998) studies the (economy-wide) tax burden, and he finds that the degree of democracy does not affect the taxes collected by the government. Empirical tests that do establish a significant relationship along the same line are often based on biased samples. As mentioned previously, Djankov et al. (2002) is one example. Other authors show that a higher degree of democracy is associated with more provision of public services (e.g., Dasgupta, 1993; Przeworski, Alvarez, and Cheibub, 2000; Lake and Baum, 2001). However, as shown by Ross (2006), their findings are also based on biased samples, and the positive relationship they claim does not exist in the World Bank's richer dataset. Our study differs from the above empirical literature by dropping the presumption that the relationship between the degree of democracy and the quality of economic institutions is linear. And we conclude from polynomial regressions a non-monotonic relationship for both the bureaucratic and tax burdens.

Our study is also related to Acemoglu and Johnson (2005) on "unbundling" different types of institutions. They examine two types of economic institutions — those protecting property rights and those enforcing contracts — and they establish that property rights institutions have a larger impact on long-run growth. In contrast, our study "unbundles" different forms of the governmental burden. Moreover, we treat those forms of burden as dependent variables, and we examine how each of them is related to political institutions.

The model in this paper falls into the theory of optimal fiscal policy.[7] Our model is closely related to a growing literature that incorporates political economy into the optimal fiscal policy problem. Models in this literature introduce some political process into an otherwise standard model of fiscal policy, and they examine whether some influential results in the literature still hold. In the Ramsey framework, Battaglini and Coate (2008) and Yared (2010) show that the tax smoothing approach established in Barro (1979) may not be optimal. Acemoglu, Golosov, and Tsyvinski (2011) show that the result of zero capital taxation established by Judd (1985) and Chamley (1986) may not hold either. Similarly, in the Mirrleesian framework, the uniform taxation result by Atkinson and Stiglitz (1976) can be overturned under some political process, as Farhi et al. (2012) and Scheuer and Wolitzky (2016) demonstrate. Similar to these papers, we introduce political economy into a standard model. The focus of our analysis, however, is the mix of capital taxation and public capital, with the latter being an efficient instrument of fiscal policy.

2 Model

We study a political-economic model of fiscal policy with overlapping generations. We examine two key policy instruments — capital taxation and public capital — and investigate how different political institutions reply on a different mix of the two in revenue-raising. After setting up the model, we discuss and justify the way we formalize political

[7]Standard treatments can be found in Chari and Kehoe (1999) for neoclassical economy and in Erosa and Gervais (2002) for overlapping-generations economy.

institutions in Subsection 2.4.

2.1 Economic Environment

We first set up the economy following standard treatment in Erosa and Gervais (2002).

2.1.1 Households

The economy is populated by overlapping generations of identical individuals. Individuals live two periods, the young and old ages. The population does not change, and the size of each cohort is normalized to one.

Each cohort-t individual values consumption at the young and old ages, denoted by c_t^y and c_{t+1}^o, respectively. She supplies one unit of inelastic labor at the young age, earns a competitive wage rate w_t, and invests k_{t+1} in capital. The key policy instruments to be introduced — capital taxation and public capital — affect both the post-policy price, $\widehat{r}_{t+1}$, and the post-policy quantity, $\widehat{k}_{t+1}$, of capital.

The problem faced by a cohort-t individual is to maximize her lifetime utility subject to two budget constraints:

$$\max_{c_t^y, c_{t+1}^o, k_{t+1}} \quad u\left(c_t^y, c_{t+1}^o\right) \tag{1}$$

$$s.t. \quad c_t^y + k_{t+1} \leq w_t; \tag{2}$$

$$c_{t+1}^o \leq \widehat{r}_{t+1}\widehat{k}_{t+1}. \tag{3}$$

We assume that u is twice differentiable, strictly increasing and strictly concave.

2.1.2 Politicians

There are a large number of potential and identical politicians. The politicians are self-interested and derive utility from their own consumption. The utility of a politician in period 0 is given by

$$\sum_{t=0}^{\infty} \gamma^t v\left(c_t^p\right),$$

where c_t^p is the politician's own consumption in period t, and γ is the discount factor for the politicians.

A politician out of power receives zero consumption. A politician in power receives positive consumption which, in equilibrium, depends on the fiscal policy.

2.1.3 Technology and Feasibility

There is a unique final good that can be consumed or used as capital. The technology is represented by a neoclassical production function with constant returns to scale: $f\left(k_t\right)$, where the aggregate (per capita) capital stock is denoted by k_t and the labor supply (normalized to 1) is omitted in the argument. For simplicity, we assume full depreciation of capital.

Capital and labor are paid their marginal outputs. That is, the pre-tax price of capital and the wage rate are given by $r_t = f'(k_t)$ and $w_t = f(k_t) - f'(k_t) k_t$, respectively.

The economy-wide resource allocation has to satisfy the feasibility constraint:

$$c_t^y + c_t^o + c_t^p + k_{t+1} \leq f(k_t), \tag{4}$$

where c_t^y, c_t^o, and c_t^p denote, respectively, the aggregate (per capita) consumption for the young, the old, and the politician in power.

2.1.4 Policies

There is a social planner who chooses the fiscal policy to maximize social welfare (specified later). We assume that the social planner has access, via the government, to three policy instruments: capital taxation, public capital, and the consumption for the politician in power. The period-t capital tax is denoted by a *flat rate* $\tau_t \leq 1$, and the period-t public capital is denoted by an *amount* $z_t \geq 0$. Therefore, for households, the post-policy price and the post-policy quantity of capital are respectively given by

$$\begin{aligned} \widehat{r}_t &= (1 - \tau_t) r_t, \\ \widehat{k}_t &= k_t - z_t. \end{aligned}$$

The only government spending is to provide the politician in power with personal consumption c_t^p. The resulting government budget constraint in period t is given by

$$c_t^p \leq (r_t - \widehat{r}_t)(k_t - z_t) + r_t z_t. \tag{5}$$

By construction, capital taxation is distortionary and disincentivizes investment, whereas public capital is acquired by the government in a lump-sum manner. Therefore, compared to capital taxation, public capital is an (economically) more efficient way of raising revenues. However, acquiring public capital is politically costly — possibly even more costly than taxing capital income — for reasons that will become clear in the political environment (next subsection). The economic and political considerations together present a trade-off for the choice of fiscal policies.

To match the stylized facts, we use capital taxation to represent *both* the bureaucratic and tax burdens in the data, because both instruments, while raising revenues, hurt the incentive of doing business. We interpret the returns to public capital in the data as a flow proxy for the stock of public capital in the model. We note that, while the acquisition of public capital in practice is not perfectly lump-sum, it often does provide efficient alternative in raising revenues. In the 1970s, for example, many governments seized foreign direct investment assets (especially those in the resource and public infrastructure sectors), which has raised a significant amount of revenues without distorting the domestic economies substantially (see Subsection A.1.3 for more details).

In Section 5, we study an extension of the model in which the government has more policy instruments. We consider elastic labor supply and allow the government to tax wage income. We also allow the government to use short-term debt to smooth the government spending over time. We show there that the main result of the model holds with the additional policy instruments.

2.2 Political Environment

We introduce a political economy into the model, following recent work by Yared (2010) and Acemoglu, Golosov, and Tsyvinski (2011).

In any period, one politician is in power. The fiscal policy sequence

$$\{\tau_{t+1}, z_{t+1}, c_t^p\}_{t=0}^{\infty}$$

is chosen by the planner in period 0. However, the chosen policy has to be carried out by the politician in power. We follow the accountability models of Barro (1973) and Ferejohn (1986) and let citizens control politicians by potentially removing them from office. In reality, depending on the political institutions, the removal might mean formal processes such as elections, or informal processes such as protests and revolutions.

The political institutions are identified by an exogenous degree of democracy, $d \in [0, 1]$, with $d = 1$ representing full democracy. The interaction between the politician in power and the citizens is characterized by the following stage game.

1. The politician in power decides whether to misbehave. If the politician misbehaves, he appropriates as much public and private capital as possible for his own consumption. We assume the magnitude of appropriation is such that a fraction $\psi_d \in (0, 1)$ of public capital z_t and a fraction $\phi_d \in (0, 1)$ of private capital $(k_t - z_t)$ are taken by the misbehaving politician.

2. Citizens individually decides consumption c_t^y and c_t^o, and capital k_{t+1} subject to their individual budget constraints.

3. Citizens collectively decide whether to replace the current politician with a new one.

The degree of democracy is modeled through the politician's misbehavior. Formally, we say that the political institutions have a higher degree of democracy if the fractions of public and private capital a misbehaving politician can appropriate are both *smaller*. That is, ψ_d and ϕ_d as functions of d are such that

$$\psi_d' \leq 0 \text{ and } \phi_d' \leq 0,$$

where ψ_d' and ϕ_d' are the derivatives with respect to d and at least one inequality is strict. Therefore, in a more democratic society, politicians are more accountable, and the magnitude of their misbehaviors is smaller.

In practice, the appropriation by a misbehaving politician might mean "privatizing" state-owned enterprises and self-dealing the privatization proceeds in the case of public capital, and incriminating entrepreneurs and confiscating their assets in the case of private capital. These misbehaviors can be restricted in democratic institutions by the separation of powers within the government and legal recourse available to private parties.

While we did not specify which between ψ_d' and ϕ_d' is larger, it is straightforward to imagine a scenario in which ϕ_d' is smaller relative to ψ_d'. In this case, as the degree of

democracy increases, the protection of private capital *improves more quickly* compared to that of public capital. The idea is that private property rights are more protected in a more democratic system, while public capital is placed under the control of the government and not as protected from the politician in power. In this scenario, having a large stock of public capital as a revenue source is politically more costly, even though it is economically more efficient.

The other scenario, in which ϕ_d' is larger relative to ψ_d', is permissible in the model, although it may not be realistic in practice. In this scenario, as the degree of democracy increases, having a large stock of public capital is economically more efficient *and politically less costly*. It follows that all revenues should be raised by public capital and capital taxation should be absent. This scenario, however, would not match the stylized facts.

We assume, for simplicity, that a misbehaving politician sells all the appropriated capital and consumes the proceeds right away. In other words, if this outside option is pursued, the period-t consumption of the politician is given by

$$c_t^{p,out} = \psi_d z_t + \phi_d \left(k_t - z_t\right). \tag{6}$$

We also assume that citizens coordinate on punishing misbehaving politicians. So, once the outside option is taken, the politician will be kept out of power by citizens forever.

Throughout the paper, we consider pure-strategy subgame perfect equilibria (SPE). We omit the details about a full definition of SPE to simplify the exposition (see Yared, 2010 for an example of such a full definition). We also leave the details of the political process in Step 3 unspecified to capture different ways misbehaving politicians can be punished in different contexts.

2.3 Objective

Following Samuelson (1968) and Atkinson and Sandmo (1980), we define social welfare as the discounted sum of individual lifetime welfare levels:

$$\sum_{t=-1}^{\infty} \beta^t U^t,$$

where U^t is the indirect utility of cohort t (as a function of policy), and β is the intergenerational discount factor. The planner's objective is to choose the fiscal policy that maximizes social welfare.[8] This approach is in spirit close to Ramsey optimal taxation models. However, the political environment in our model creates political frictions, and such political frictions will move the resulting allocation away from the second-best allocation seen in optimal taxation models.

[8]Alternatively, Yared (2010) and Acemoglu, Golosov, and Tsyvinski (2011) assume that policies are directly chosen by the politician in power (in the absence of a social planner). There, they select and analyze the "best" SPE, the SPE that maximizes social welfare.

2.4 Remarks on Modeling Political Institutions

We have built through the stage game a political environment in which the politician, a player supposed to carry out the policy, is *not* perfectly accountable. From there, we generated the variation in the degree of democracy in the sense that the politician's misbehavior is more limited in a more democratic system. This is consistent with popular measures of democracy in the political science literature (such as the Polity IV data used in this paper): Democracy is not only about whether citizens can elect or remove their chief executive but also about the extent to which the chief executive's power can be constrained by institutions.

In practice, the variation in the degree of democracy — or, accountability — can take different forms, which we do not explicitly model in the paper. Removing a politician from office can be costly to citizens, and such cost is arguably lower in a more democratic system. In this case, a lower removal cost implies that a relatively mild misbehavior can easily cause the displacement of a politician in power.[9] And a higher removal cost, for the same reason, means a more severe misbehavior. Alternatively, a higher degree of democracy might mean that it takes less time for citizens to remove a misbehaving politician should they decide to do so. Since the removal time is shorter, it leaves fewer opportunities for the politician to appropriate public and private capital before being displaced. This also leads to a milder misbehavior as formalized in our model.

There is no question that, in reality, political institutions are endogenous. However, we think that, in general, political institutions evolve more slowly than economic policies such as bureaucratic burden, tax burden, and public capital — the endogenous variables to be studied in this paper. To match the stylized facts, therefore, we treat the degree of democracy as exogenous in the model.

Our model differs from standard optimal taxation models in an important way. We introduced public capital as a new policy instrument. Since the acquisition of public capital is lump-sum, the consequence of having this instrument in standard optimal taxation models would be trivial because the first-best allocation would always be achieved by setting the distortionary capital tax at zero. However, in our model, the role of public capital is non-trivial because, albeit non-distortionary, it creates political frictions. As we show later, an increase in public capital leads to an increase in the politician's consumption resulting from the improvement of the politician's outside option, incentivizing him to misbehave.

3 Optimal Fiscal Policy

The planner's problem is to choose a set of capital taxes and public capitals so that the resulting allocation maximizes social welfare and, no less importantly, the policy will indeed be carried out by the self-interested politician in power. In this section, we first show an equivalent formulation of the problem in which allocations, instead of policies, are the choice variables. We then characterize the optimal allocation and, accordingly,

[9]The model in Yared (2010), for example, has this feature.

the optimal policy in the steady state.

3.1 Equivalent Formulation

We first derive the implementability condition, a condition under which a feasible allocation can be decentralized as a competitive equilibrium.

Definition 1. *Given initial conditions, an allocation* $\{c_t^y, c_t^o, c_t^p, k_{t+1}, z_{t+1}\}_{t=0}^{\infty}$ *is implementable if it can be decentralized as a competitive equilibrium. That is, there exist a sequence of capital tax rates* $\{\tau_{t+1}\}_{t=0}^{\infty}$ *such that:*

(i) *given tax rates* $\{\tau_{t+1}\}_{t=0}^{\infty}$ *and public capital* $\{z_{t+1}\}_{t=0}^{\infty}$, $\left\{c_t^y, c_{t+1}^o, k_{t+1}\right\}_{t=0}^{\infty}$ *solves the household problem* (1)-(3)*;*

(ii) *pre-tax prices* $\{r_t, w_t\}_{t=0}^{\infty}$ *clear the factor markets;*

(iii) *the government budget constraint* (5) *is satisfied in each period* t*;*

(iv) *the feasibility constraint* (4) *is satisfied in each period* t*.*

Given the assumptions imposed on u earlier, the necessary and sufficient conditions for a solution to the household problem are given by the household budget constraints and the following first-order condition:

$$\widehat{r}_{t+1} u_{c^o}(t) = u_{c^y}(t), \tag{7}$$

where (t) is the shorthand for argument $\left(c_t^y, c_{t+1}^o\right)$.

We follow the primal approach, a standard technique in the Ramsey taxation literature, to construct a sequence of implementability constraints. This approach turns the problem into one of choosing allocations rather than policies.

Lemma 1. *An allocation* $\{c_t^y, c_t^o, c_t^p, k_{t+1}, z_{t+1}\}_{t=0}^{\infty}$ *is implementable if and only if it satisfies the feasibility constraint* (4) *and the following implementability constraint*

$$u_{c^y}(t)(z_{t+1} - k_{t+1}) + u_{c^o}(t) c_{t+1}^o = 0 \tag{8}$$

in each period t*.*

Lemma 1 shows that a feasible allocation can be decentralized as a competitive equilibrium if and only if the implementability constraint (8) is satisfied. Accordingly, the welfare-maximizing allocation can be decentralized as a competitive equilibrium if and only if it satisfies (8) as well. Note that the only difference between condition (8)and standard implementability constraints in the literature is the presence of public capital z_{t+1} in the equation.

Even if an allocation is implementable, the politician in power may not find it profitable to carry out the policy chosen by the planner. Thus, the welfare-maximizing allocation should be such that misbehavior is never pursued by the politician in power.[10]

[10]In terms of inducing politicians' cooperation, keeping the same politician in power forever and offering him some level of consumption takes a smaller amount of resources compared to the alternative scenario in which politicians are frequently thrown out of power.

Definition 2. *Given initial conditions, an allocation* $\{c_t^y, c_t^o, c_t^p, k_{t+1}, z_{t+1}\}_{t=0}^{\infty}$ *is sustainable if the politician in power never chooses to misbehave by appropriating capital.*

Lemma 2. *An allocation* $\{c_t^y, c_t^o, c_t^p, k_{t+1}, z_{t+1}\}_{t=0}^{\infty}$ *is sustainable if and only if it satisfies the following sustainability constraint*

$$v\left(\psi_d z_t + \phi_d\left(k_t - z_t\right)\right) \leq \sum_{s=0}^{\infty} \gamma^s v\left(c_{t+s}^p\right) \tag{9}$$

in each period t*.*

The interpretation of the sustainability condition (9) is straightforward. The left-hand side corresponds to the politician's consumption in the scenario of taking the outside option (from equation (6)), whereas the right-hand side represents the continuation payoffs if the politician stays in power and enjoys the office perks forever. Due to the politician's outside option, the planner has to provide enough office perks, so that absconding is not profitable from the politician's perspective.

We are now in the position to state an equivalent formulation of the planner's problem. The welfare-maximizing allocation is characterized by the solution to the following program:

$$\begin{aligned} \max_{\left\{c_t^y, c_t^o, c_t^p, k_{t+1}, z_{t+1}\right\}_{t=0}^{\infty}} \quad & \sum_{t=0}^{\infty} \beta^t u\left(c_t^y, c_{t+1}^o\right) \\ s.t. \quad & \text{feasibility, (4);} \\ & \text{implementability, (8);} \\ & \text{sustainability, (9).} \end{aligned}$$

That is, the welfare-maximizing allocation has to be feasible economy-wide, (4); implementable through competitive markets, (8); and sustainable under the presence of a self-interested politician, (9).

Note that this program is connected to standard models in the literature in two aspects. First, if policies were chosen in the absence of self-interested politicians, the sustainability constraint would be eliminated, and the problem would be reduced to optimal taxation with *lump-sum* acquisition of public capital. The solution would be trivial because the first-best allocation would be achieved by only using public capital in revenue-raising.

Second, if public capital were not included in the policy instruments, the problem would be reduced to an optimal taxation problem with political economy (e.g., Yared, 2010; Acemoglu, Golosov, and Tsyvinski, 2011). Our model differs in that public capital is an admissible policy instrument, and it plays a non-trivial role through the two constraints (8) and (9).

3.2 Optimal Allocation and Optimal Policy

In this subsection, we study the solution to the planner's problem. Due to the overlapping generations, the steady state of the solution (as well as the optimal policy associated

with it) is independent of the transition path and can be solved analytically. For this reason, we focus the analysis on the steady state only.

Let $\beta^t \mu_t$ be the Lagrangian multiplier associated with cohort-t's implementability constraint (8) and define a pseudo welfare function that incorporates the implementability constraint:

$$\begin{aligned} W\left(c_t^y, c_{t+1}^o, k_t, z_{t+1}\right) \equiv\ & u\left(c_t^y, c_{t+1}^o\right) \\ & -\mu_t\left[u_{c^y}(t)\left(z_{t+1}-k_{t+1}\right)+u_{c^o}(t)\, c_{t+1}^o\right]. \end{aligned}$$

The problem becomes maximizing $\sum_{t=0}^{\infty} \beta^t W\left(c_t^y, c_{t+1}^o, k_t, z_{t+1}\right)$ subject to just two constraints (4) and (9). Let $\beta^t \lambda_t$ and $\beta^t \eta_t$ be the Lagrangian multipliers associated with period-t constraints (4) and (9), respectively. Suppose the solution is in the interior. Then, the first-order conditions for the solution are constraints (4), (8) and (9), as well as:

$$[c_t^y] \ :\ W_{c^y}(t) - \lambda_t = 0; \tag{10}$$

$$\left[c_{t+1}^o\right] \ :\ W_{c^o}(t) - \beta\lambda_{t+1} = 0; \tag{11}$$

$$[k_{t+1}] \ :\ W_k(t) - \lambda_t + \beta\lambda_{t+1} f'(t+1) - \beta\eta_{t+1} v'(t+1)\,\phi_d = 0; \tag{12}$$

$$[z_{t+1}] \ :\ W_z(t) - \beta\eta_{t+1} v'(t+1)\left(\psi_d - \phi_d\right) = 0; \tag{13}$$

$$[c_t^p] \ :\ -\lambda_t + \sum_{s=0}^{t} (\gamma/\beta)^{t-s}\, \eta_s v'\left(c_t^p\right) = 0; \tag{14}$$

where (t) in $v'(t)$ is the shorthand for argument $(\psi_d z_t + \phi_d(k_t - z_t))$ (see constraint (9)).

We are interested in how the degree of democracy affects the steady state. However, it turns out that the political environment may or may not matter in the steady state. The next lemma specifies the condition under which it *does* play a nontrivial role.

Lemma 3. *Suppose a steady state exists, then:*

(i) *if the politicians are at least as patient as the social planer (i.e., if $\gamma = \beta$), the sustainability constraint* (9) *becomes slack as $t \to \infty$;*

(ii) *if the politicians are less patient than the social planer (i.e., if $\gamma < \beta$), the sustainability constraint* (9) *binds as $t \to \infty$.*

The intuition of Lemma 3 is straightforward — if the politicians are patient enough, staying in power forever always dominates misbehaving which involves being kept out of office by citizens forever. Therefore, in Scenario (i), (9) does not bind as $t \to \infty$. Note that the optimal policy is trivial in this scenario because public capital becomes an efficient *and costless* policy instrument in the steady state. It follows that, as $t \to \infty$, $\tau_t \to 0$, and the steady-state consumption for the politician, c^{p*}, will be financed solely by public capital. Thus, to make things interesting, we make the following assumption.

Assumption 1. *A steady state exists, and $\gamma < \beta$.*

The first-order conditions in the steady state become:

$$[c^y] \quad : \quad W_{c^y} - \lambda = 0; \tag{15}$$

$$[c^o] \quad : \quad W_{c^o} - \beta\lambda = 0; \tag{16}$$

$$[k] \quad : \quad W_k - \lambda + \beta\lambda f' - \beta\eta v'\phi_d = 0; \tag{17}$$

$$[z] \quad : \quad W_z - \beta\eta v'\left(\psi_d - \phi_d\right) = 0; \tag{18}$$

$$[c^p] \quad : \quad \frac{\eta}{\lambda} v'\left(c^{p*}\right) = \left(1 - \frac{\gamma}{\beta}\right); \tag{19}$$

as well as the steady-state version of constraints (4), (8) and (9).

The steady-state allocation can then be used to back out the optimal capital tax. To see this, solve for $f'(k)$ in condition (17) and obtain

$$f' = \frac{1}{\beta} - \frac{1}{\beta\lambda} W_k + \frac{\eta}{\lambda} v'\phi_d.$$

Recall the household first-order condition (7):

$$\widehat{r} = (1 - \tau)\, r = \frac{u_{c^y}}{u_{c^o}}.$$

Putting the above two equations together gives

$$\tau^* = 1 - \frac{u_{c^y}}{u_{c^o}} \left(\frac{1}{\beta} - \frac{1}{\beta\lambda} W_k + \frac{\eta}{\lambda} v'\phi_d\right)^{-1}$$

which is pinned down by the steady-state allocation.

The expression of the optimal capital tax highlights how the political frictions play a role. In standard optimal taxation models without self-interested politicians, the sustainability constraint would be absent in the program, and the optimal capital tax in the steady state would become

$$\bar{\tau}^* = 1 - \frac{\bar{u}_{c^y}}{\bar{u}_{c^o}} \left(\frac{1}{\beta} - \frac{1}{\beta\bar{\lambda}} \overline{W}_k\right)^{-1},$$

where the upper-bars identify the terms in a standard model without self-interested politicians. In our model, $\eta v'\phi_d/\lambda > 0$, driving τ^* higher than $\bar{\tau}^*$. The presence of this additional term means a higher capital tax has to be levied to finance the consumption for the self-interested politician and incentivize him not to misbehave.

More importantly, the political environment in our model allows us to examine how the optimal policy varies in the degree of democracy, d. This is the focus of the next section.

4 Optimal Fiscal Policy and the Degree of Democracy

4.1 Two Effects of Democracy

The degree of democracy enters the welfare-maximization problem only from the sustainability constraint (9) or, more specifically, the politician's consumption in the scenario

of misbehaving. The steady-state version of constraint (9) is:

$$v\left(c^{p,out*}\right) = v\left(\psi_d z^* + \phi_d\left(k^* - z^*\right)\right) = \frac{v\left(c^{p*}\right)}{1-\gamma}.$$

From this constraint, we can see two effects of a higher degree of democracy on the fiscal policy — a "level" effect and a "substitution" effect. They are key to understanding the intuition of the main results.

4.1.1 Level Effect

A higher degree of democracy d lowers the fraction ψ_d of public capital and the fraction ϕ_d of private capital the misbehaving politician can appropriate. Accordingly, the politician's outside option becomes less attractive because the consumption in the scenario of misbehaving, $c^{p,out*}$, becomes lower. That is,

$$\frac{\partial c^{p,out*}}{\partial \psi}\psi_d' + \frac{\partial c^{p,out*}}{\partial \phi}\phi_d' < 0.$$

In keeping the politician in line, the welfare-maximizing planner can reduce the office perks c^{p*} accordingly. To finance this lower *level* of office perks, the planner can afford to reduce both public capital and capital tax — *the level effect*.

4.1.2 Substitution Effect

From the planner's point of view, there can be a trade-off between improving the efficiency of revenue-raising and curbing the office perks for the politician. For efficiency's sake, the welfare-maximizing planner would prefer the lump-sum acquisition of public capital to the distortionary capital taxation in revenue-raising. However, public capital can be politically costly. This is because using this revenue source increases the stock of public capital z^*, a fraction ψ_d of which is unprotected from the politician, and it decreases the stock of private capital $(k^* - z^*)$, with a fraction ϕ_d of it unprotected. The marginal (political) cost of increasing the stock of public capital is hence given by

$$\frac{\partial c^{p,out*}}{\partial z} = \psi_d - \phi_d.$$

As the degree of democracy increases, the change in this marginal cost depends on the relative sizes of ψ_d' and ϕ_d'. In particular, if ϕ_d' is smaller relative to ψ_d', public capital becomes more costly as the political institutions become more democratic. Consequently, under a higher degree of democracy, the planner has an incentive to *substitute* public capital with capital tax in revenue-raising — *the substitution effect*. The impact on capital tax, therefore, goes the opposite direction compared to the level effect, presenting a trade-off to the planner. If, instead, ψ_d' is relatively smaller, the trade-off would be absent because the substitution effect would also point to a smaller stock of public capital.

To sum up, with a higher degree of democracy, both the level and substitution effects suggest that public capital is lower. However, the two effects can work in opposite directions in determining capital tax. The net effect on capital tax, hence, is ambiguous.

4.2 Analytical Results

To make further progress, we impose a standard functional form assumption on the household utility function u, the politician's utility function v, and the production function f. Under this functional form assumption, we can derive conditions under which the substitution effect dominates (or, is dominated by) the level effect in determining capital tax. Furthermore, the functional form assumption allows us to derive analytical results that can match the stylized facts established previously.

Assumption 2. *The household utility function u, the politician's utility function v, and the production function f take the following forms, respectively:*

$$\begin{aligned} u\left(c_t^y, c_{t+1}^o\right) &= \ln c_t^y + \beta_i \ln c_{t+1}^o; \\ v\left(c_t^p\right) &= c_t^p; \\ f\left(k_t\right) &= k_t^\alpha. \end{aligned}$$

For simplicity, let $\beta_i = \beta$ for all households i.

That is, households have log utility, the politician's utility function is linear, and the production function is Cobb-Douglas. Note that, under this functional form assumption, the implementability constraint (8) is simplified to

$$\frac{z_{t+1} - k_{t+1}}{c_t^y} + \beta = 0.$$

In what follows, we deliver analytical results using the simple functional form. Firstly, recall that public capital is subject to non-negativity constraint $z_t \geq 0$. When this constraint is binding, the problem is simplified to one of finding the optimal capital tax. We start the analysis from this simpler case.

If public capital is at the *corner* of $z^* = 0$, the first-order conditions (15)-(19) are reduced to

$$\begin{aligned} [c^y] &: \frac{1}{c^y} - \frac{\mu}{c^y}\frac{k}{c^y} - \lambda = 0; \\ [c^o] &: \frac{1}{c^o} - \lambda = 0; \\ [k] &: \frac{\mu}{c^y} - \lambda + \beta\lambda f' - \beta\eta\phi_d = 0; \\ [c^p] &: \frac{\eta}{\lambda} = \left(1 - \frac{\gamma}{\beta}\right); \end{aligned}$$

where the counterpart of (18) is eliminated. These four equations, together with the steady-state version of constraints (4), (8) and (9), allow us to solve for the steady-state allocation and back out the steady-state capital tax.

Proposition 1. *Under Assumptions 1 and 2, in the steady state, if the public capital is minimal (i.e., at the corner of $z = 0$), then the capital tax, $\tau^*|_{z=0}$, is* decreasing *in the degree of democracy, d.*

To see the intuition of Proposition 1, we write out the sustainability constraint (9) in the steady state *without* public capital:

$$c^{p,out*} = \phi_d k^* = \frac{c^{p*}}{1-\gamma}.$$

Since public capital is bounded from below by zero, there is no substitution between capital tax and public capital, and the level effect is the only effect present. If the degree of democracy d increases, the limit on the appropriation of private capital by a misbehaving politician becomes more stringent (i.e., a lower ϕ_d), and the politician's consumption in the scenario of misbehaving, $\phi_d k^*$, becomes lower. In keeping the sustainability constraint at equality, the level of office perks c^{p*} decreases accordingly. Since taxation is the only policy instrument in use, this means capital tax τ^* becomes smaller.

Proposition 1 is reminiscent of the conventional wisdom, exemplified by Djankov et al. (2002), that respect for political rights is associated with respect for economic rights. A higher degree of democracy, in this result, lowers the level of office perks for the self-interested politician which, in turn, allows the welfare-maximizing planner to reduce the distortionary capital tax. Such effect, however, is under the presumption that public capital stays at a constant level (zero in this case).

In fact, public capital could be strictly positive in equilibrium. If public capital is in the *interior*, i.e., $z^* > 0$, the first-order conditions (15)-(19) become

$$\begin{aligned}
[c^y] \quad &: \quad \frac{1}{c^y} + \frac{\mu}{c^y}\frac{z-k}{c^y} - \lambda = 0; \\
[c^o] \quad &: \quad \frac{1}{c^o} - \lambda = 0; \\
[k] \quad &: \quad \frac{\mu}{c^y} - \lambda + \beta\lambda f' - \beta\eta\phi_d = 0; \\
[z] \quad &: \quad -\frac{\mu}{c^y} - \beta\eta\left(\psi_d - \phi_d\right) = 0; \\
[c^p] \quad &: \quad \frac{\eta}{\lambda} = \left(1 - \frac{\gamma}{\beta}\right).
\end{aligned}$$

The steady-state allocation is identified with these five conditions as well as the steady-state version of constraints (4), (8) and (9).

The next two propositions characterize the steady-state capital tax and steady-state public capital associated with this allocation.

Proposition 2. *Under Assumptions 1 and 2, in the steady state, if the public capital is positive (i.e., $z^* > 0$), then there exists two thresholds M_1 and M_2 with $M_2 > M_1 > 0$ such that:*

(i) *the capital tax, τ^*, decreases in the degree of democracy, d,* more slowly *than $\tau^*|_{z=0}$ does if and only if $\phi'_d < M_1\psi'_d$;*

(ii) *the capital tax, τ^*,* increases *in the degree of democracy, d, if and only if $\phi'_d < M_2\psi'_d$.*

Proposition 3. *Under Assumptions 1 and 2, in the steady state, if the public capital is positive (i.e., $z^* > 0$), then there exists a threshold $N > 0$ such that, if $\phi'_d < N\psi'_d$, the public capital, z^*,* decrease *in the degree of democracy, d.*

By Propositions 2 and 3, the impact of an increasing degree of democracy depends on the extent to which it improves the protection of public and private capital from a politician's misbehavior. If a higher degree of democracy improves the protection of private capital *sufficiently more quickly* than it improves the protection of public capital, then, as the political system becomes more democratic, public capital decreases, and capital tax can be decreasing *more slowly* compared to the case with zero public capital, or even be increasing.

The key to understanding the intuition of the two propositions is the role of public capital as a revenue source alternative to capital taxation. Compared to taxing capital income, holding public capital is economically more efficient but can be politically more costly. Recall the sustainability constraint (9) in the steady state, which is written as

$$c^{p,out*} = \psi_d z^* + \phi_d \left(k^* - z^*\right) = \frac{c^{p*}}{1-\gamma}.$$

It follows from Subsection 4.1 that the level effect of democracy leads to a more accountable politician, fewer office perks to prevent misbehaviors and, hence, less public capital and a lower capital tax. On the other hand, by the substitution effect of democracy, the political cost of using public capital in revenue-raising depends on the relative sizes of ψ'_d and ϕ'_d:

$$\frac{\partial}{\partial d}\left(\frac{\partial c^{p,out*}}{\partial z}\right) = \psi'_d - \phi'_d.$$

If $\phi'_d < \psi'_d$, the political cost is higher in a more democratic system, which implies a benefit for the planner to use less public capital but more capital taxation in raising revenues. The smaller ϕ'_d is relative to ψ'_d, the more vulnerable public capital is — relative to private capital — to the politician's misbehavior, and the more the planner relies on capital taxation in revenue-raising. Therefore, when ϕ'_d is small enough (i.e., below threshold $M_1\psi'_d$), the substitution effect would dominate the level effect, and the outcome would be such that the stock of public capital decreases in the degree of democracy, and that the capital tax rate is higher than when the substitution effect is absent. The capital tax rate may even be increasing in the degree of democracy if ϕ'_d is sufficiently small (i.e., below the more stringent threshold $M_2\psi'_d$).

The opposite case would be when a higher degree of democracy improves the protection of private capital more *slowly* than it improves the protection of public capital. That is, ϕ'_d is sufficiently large compared to ψ'_d. Although less realistic in practice, this scenario implies that both the level and substitution effects lead to a lower capital tax rate. In other words, the capital tax would be decreasing in the degree of democracy more rapidly than when the substitution effect is absent. This result, however, would not be able to match the stylized established at the beginning of the paper.

4.3 Matching the Stylized Facts with a Numerical Example

In this subsection, we illustrate the previous analytical results using a numerical example. The example allows us to match the stylized facts.

Specifically, we assume that a misbehaving politician at time t appropriates all public capital z_t (i.e., $\psi_d \equiv 1$) and that the limit ϕ_d on the appropriation of private capital follows

$$\phi_d \equiv 0.7 - 0.3d.$$

That is, under democracy, a misbehaving politician can appropriate 40% of private capital, whereas, under autocracy, this fraction becomes 70%. The key of this specification is that $\psi_d' = 0$. This implies that all the conditions in Propositions 2 and 3 are satisfied, and that the substitution effect dominates the level effect in the planner's choice on capital taxation.

We also set the values of parameters at: $\alpha = 0.5$, $\beta = 0.7$, and $\gamma = 0.3$. Under these specifications, the politician is less patient than the planner (i.e., $\gamma < \beta$), as Assumption 1 requires, which implies that the steady state exists.

Under these numerical assumptions, we calculate the steady-state allocation and plot the optimal policy (capital taxation and public capital) against the degree of democracy in Figure 5.

Figure 5
Fiscal policy in the steady state.

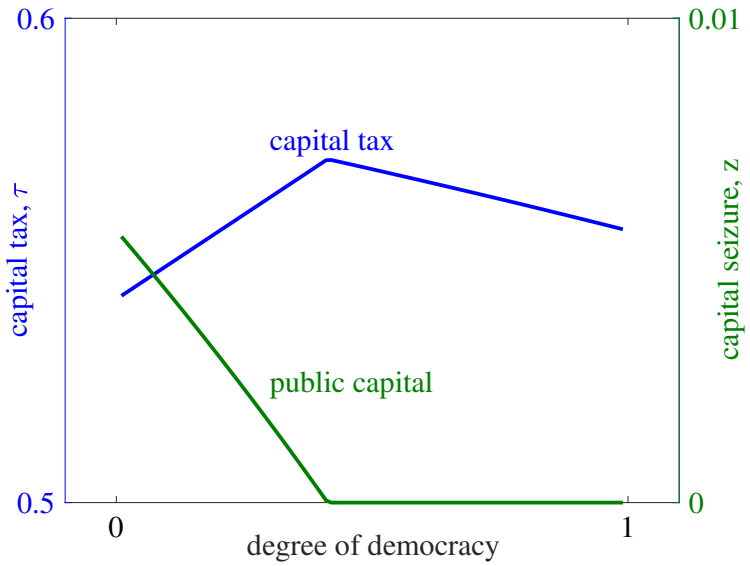


Figure 5 has a feature which is key to matching the stylized facts. That is, there is a cut-off degree of democracy between 0 and 1 such that: (1) if the degree of democracy is higher than this cut-off, public capital is so costly that it is kept at the corner solution (zero); (2) if the degree of democracy is lower than this cut-off, public capital is not too costly and, hence, strictly positive. This feature allows the example to match the stylized facts established previously.

On the right side of Figure 5, i.e., case (1), countries are relatively more democratic, and public capital is *not* used because it is too costly from the planner's perspective. In this case, the substitution effect is *absent*, and the level effect is the only effect present. As the degree of democracy increases, capital tax decreases (Proposition 1). Put differently, the governmental burden on businesses, in the form of bureaucracy or taxation, is lighter in a more democratic system.

On the left side of Figure 5, i.e., case (2), countries are relatively less democratic, and, no less importantly, public capital is *not* too costly for the planner to use. Therefore, both the level and substitution effects are present. Furthermore, due to the functional form assumption, the substitution effect dominates the level effect. Thus, as the degree of democracy increases, capital tax becomes higher (Proposition 2) while public capital becomes lower (Proposition 3). In other words, the prediction is that the bureaucratic and tax burdens are increasing in the degree of democracy. The two sides of Figure 5 together, therefore, matches the inverted-U shape established in Figures 2 and 3.

Besides matching the stylized fact, the model also has a prediction about public capital — the amount of public capital is decreasing in the degree of democracy. The stylized fact established in Figure 4, albeit using a flow measure to proxy for the stock of public capital, seems to confirm this prediction.

5 Extension: More Policy Instruments

Thus far, we have not considered labor taxation and short-term debt as admissible instruments for the fiscal policy. In this section, we extend the baseline model by considering elastic labor supply and including these two instruments.

5.1 Preliminaries

Specifically, let cohort-t individuals decide, at their young age, labor supply ℓ_t. Capital tax and labor tax are denoted by τ_t^k and τ_t^ℓ, respectively. Individual utility function is modified to $u\left(c_t^y, \ell_t, c_{t+1}^o\right)$, where labor supply incurs disutility. The production function is modified to $f\left(k, \ell\right) = k^\alpha \ell^{1-\alpha}$, and the assumption of full depreciation is kept. Due to the presence of short-term debt and labor taxation, the household problem becomes

$$\begin{aligned} \max_{c_t^y, \ell_t, c_{t+1}^o, a_{t+1}} \quad & u\left(c_t^y, \ell_t, c_{t+1}^o\right) \\ s.t. \quad & c_t^y + a_{t+1} \leq \widehat{w}_t \ell_t; \\ & c_{t+1}^o \leq \widehat{r}_{t+1} \widehat{a}_{t+1}. \end{aligned}$$

where $\widehat{w}_t$ and $\widehat{r}_{t+1}$ are post-tax prices, a_{t+1} denotes the initial asset holding, and $\widehat{a}_{t+1}$ represents the asset holding after the acquisition of public capital. These variables satisfy the following conditions:

$$\begin{aligned} \widehat{w}_t &= \left(1 - \tau_t^\ell\right) w_t; \\ \widehat{r}_{t+1} &= \left(1 - \tau_{t+1}^k\right) r_{t+1}; \end{aligned}$$

$$\widehat{a}_{t+1} \quad = \quad a_{t+1} - z_{t+1}.$$

Let b_t be one-period bonds the government issues. Accordingly, the government budget constraint becomes

$$c_t^p + b_t \leq (w_t - \widehat{w}_t)\,\ell_t + (r_t - \widehat{r}_t)\,(k_t - z_t) + r_t z_t + q_{t+1} b_{t+1},$$

where q_{t+1} is the price of the bonds b_{t+1}. For households, the asset holding a_{t+1} can be in the form of private capital or government bonds, the returns to which are equalized in equilibrium.

The feasibility constraint is modified to

$$c_t^y + c_t^o + c_t^p + k_{t+1} \leq f\,(k_t, \ell_t)\,, \tag{20}$$

and the implementability becomes

$$u_{c^y}\,(t)\,(c_t^y + z_{t+1}) + u_\ell \ell_t + u_{c^o}\,(t)\,c_{t+1}^o = 0. \tag{21}$$

In the stage game, we modify the politician's outside option — misbehavior — as follows. If the politician decides to misbehave, he appropriates a fraction ψ_d of the returns to public capital (i.e., $\psi_d r_t z_t$). In addition, the politician also appropriates:a fraction ϕ_d of the returns to private capital, $r_t\,(k_t - z_t)$, and the same fraction ϕ_d of the returns to labor, $w_t \ell_t$. We assume as before that the absconding politician consumes all the proceeds right away. Therefore, the politician's consumption in the scenario of taking the outside option is modified to

$$c_t^{p,out} = \psi_d r_t z_t + \phi_d\,[w_t \ell_t + r_t\,(k_t - z_t)]\,.$$

Note that, for consistency, we have changed the appropriation by a misbehaving politician from the stock of private capital in the baseline model to that of all private income in this generalized model (i.e., the returns to private capital and the wage income).

Accordingly, the sustainability constraint becomes

$$\psi_d r_t z_t + \phi_d\,[w_t \ell_t + r_t\,(k_t - z_t)] \leq \sum_s \gamma^s c_{t+s}^p. \tag{22}$$

These changes lead to a program analogous to that in Section 3:

$$\begin{aligned} \max_{\left\{c_t^y, \ell_t, c_t^o, c_t^p, k_{t+1}, z_{t+1}\right\}_{t=0}^{\infty}} \quad & \sum_{t=0}^{\infty} \beta^t u\left(c_t^y, \ell_t, c_{t+1}^o\right) \\ s.t. \quad & \text{feasibility, (20);} \\ & \text{implementability, (21);} \\ & \text{sustainability, (22).} \end{aligned}$$

5.2 Numerical Example

Due to the additional policy instruments, deriving analytical results as in Propositions 1-3 is less straightforward. In what follows, we make a similar functional form assumption, and we adopt a numerical analysis similar to Subsection 4.2.

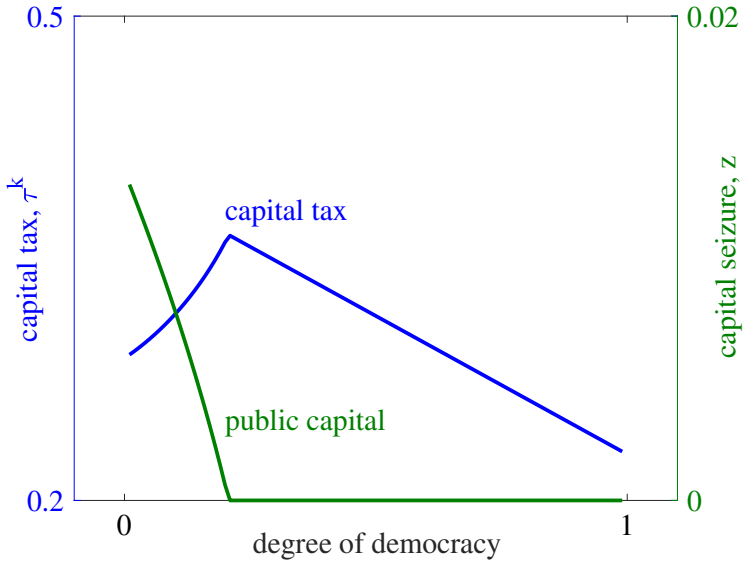
Consider the following functional forms:

$$\begin{aligned} u\left(c_t^y, \ell_t, c_{t+1}^o\right) &= \ln c_t^y + \ln\left(1-\ell_t\right) + \beta_i \ln c_{t+1}^o; \\ v\left(c_t^p\right) &= c_t^p; \\ f\left(k_t\right) &= k_t^\alpha \ell_t^{1-\alpha}; \end{aligned}$$

where $\beta_i = \beta$ for all i, as before. We let $\psi_d \equiv 1$ and $\phi_d \equiv 0.7 - 0.3d$ as before, and we set the parameters at $\alpha = 0.4$, $\beta = 0.7$, and $\gamma = 0.3$.

As before, we compute the steady-state allocation and plot the optimal policy — capital taxation, labor taxation, and public capital — against the degree of democracy. Figures 6 and 7, respectively, show the capital and labor taxes in relation to public capital.

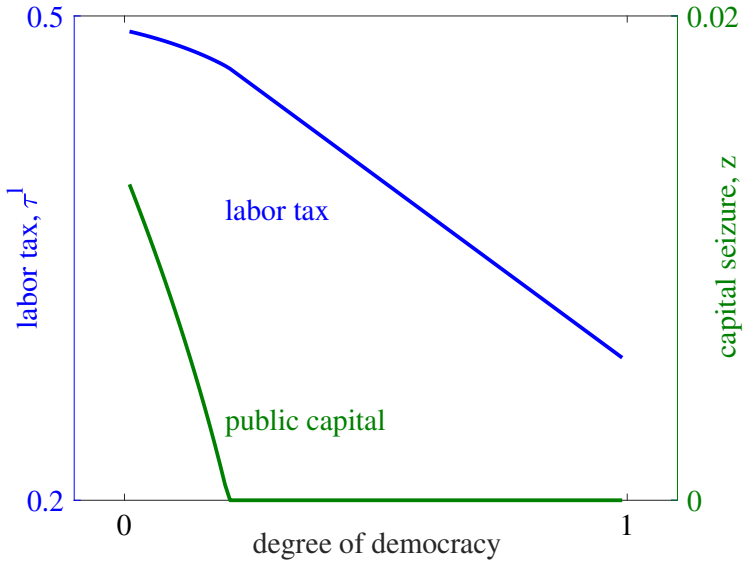
Figure 6
Extension — fiscal policy in the steady state, part 1.



Two observations follow. Firstly, Figure 6 — about capital tax τ^{k*} and public capital z^* in the steady state — is qualitatively similar to Figure 5 and consistent with the second case in Proposition 2. There is a similar cut-off degree of democracy between 0 and 1 such that public capital is: (1) zero if the degree of democracy is higher than this cut-off; and (2) strictly positive if the degree of democracy is lower than this cut-off. As in Figure 5, this feature allows the example to match the stylized facts established previously.

Secondly, in Figure 7, the curve for labor tax $\tau^{\ell*}$ is downward sloping for all degrees of democracy between 0 and 1. Yet, due to the substitution effect, the labor tax decreases

Figure 7
Extension — fiscal policy in the steady state, part 2.



in the degree of democracy *more slowly* on the left side of the figure (where public capital is positive) than it would have been had the public capital been constrained by $z = 0$. This is, therefore, consistent with the first case in Proposition 2.

6 Conclusion

We have established two stylized facts about the governmental burden on businesses: Both the bureaucratic and tax burdens have an inverted-U relationship with the degree of democracy. To match these stylized facts, we have developed a dynamic political-economic model of fiscal policy in which the key policy instruments are: (1) distortionary capital taxation, representing both the bureaucratic and tax burdens; and (2) public capital acquired in a lump-sum manner. In the model, the fiscal policy is chosen by a welfare-maximizing social planner but carried out by a self-interested politician who might misbehave by appropriating public and private capital. We have shown that a higher degree of democracy has two effects on the fiscal policy. The "level" effect suggests that both public capital and capital tax tend to decrease, while the "substitution" effect suggests that the planner may find it optimal to substitute public capital with capital taxation in revenue-raising. We have shown that, under a standard functional form assumption, the substitution effect can dominate the level effect in determining capital tax, and that the model can match the stylized facts established previously.

In matching the stylized facts, the model makes a prediction about public capital — the amount of capital is decreasing in the degree of democracy. We have established a third stylized fact that seems to confirm this prediction — a negative relationship between the returns to public capital and the degree of democracy.

Admittedly, the stylized facts established in this paper are mere correlations. Nev-

ertheless, our model suggests a causal channel that can reproduce the stylized facts. If such causality indeed exists, the model delivers several interesting implications. Firstly, if an autocratic regime (e.g., China) democratizes, the theory suggests that its government may become *less* business-friendly. Secondly, as an alternative interpretation of such causality, a democratization process may face opposition not only from politicians *but also from businesses*. Finally, the substitution effect in the model suggests that a decline of public capital may be seen as a *predictor* of a heavier burden on businesses. It would be interesting to identify whether the causality within the model indeed exists, and we leave this to future research.

Appendix

A.1 Empirics

A.1.1 Data Sources

The degree of democracy is measured by the democracy indicator in the Polity IV database (originally on a scale of 0 to 10). The indicator is derived from the extent to which (1) political participation is competitive (2) executive recruitment is open and competitive, and (3) constraints on the chief executive are stringent.[11] Figure 1 uses data for the year 1999, while Figures 2-4 use data averaged over the period 2005-2013 and, when plotted, re-scaled to being from 0 to 1.

For Figure 1, the bureaucratic procedures for starting a business are the original data in Djankov et al. (2002). For Figure 2, the data are from the World Bank's Doing Business database. In this paper, we consider three types of bureaucratic procedures: (1) the procedures for an entrepreneur to start a business, (2) the procedures for a business to build a warehouse, and (3) the procedures for a business to obtain a permanent electricity connection for a warehouse. We use the time to complete these procedures (in years) to measure the bureaucratic burden.[12] Figure 2 uses data averaged over the period 2005-2014.

The tax data are also from the World Bank's Doing Business database (available only from 2013). The tax rate is the effective rate — the actual corporate income tax payable by a business divided by its commercial profit. Figure 3 uses data averaged over the period 2013-2014.

The IMF's database, Government Finance Statistics, categorizes government revenues into taxes, social contributions, grants, and other revenues. In the category of

[11]The database has an autocracy indicator and also a combined measure, the polity score, derived by subtracting the autocracy indicator from the democracy indicator. Using the polity score as an alternative measure yields qualitatively the same results.

[12]There are other types of procedures in the database. We do not include them because they are more pertinent to other issues (e.g., the procedures for trading across border which is more pertinent to the openness of an economy) or the measurement is less comparable to the three types of procedures included (e.g., the time it takes (hours per year) to prepare, file and pay taxes).

other revenues, data about government's property income (including interest, dividends, rent, etc.) are available. We use the property income of the government to measure the returns to public capital.[13] Figure 4 uses data averaged over the period 2005-2012.

A.1.2 Robustness of Cross-Country Regressions

Firstly, we address the robustness of the inverted-U relationship in Figures 2 and 3. The inverted-U curve is obtained from a polynomial regression of the bureaucratic and tax burdens on the degree of democracy and its square term. For the bureaucratic burden, the coefficient of the square term is negative and significant. However, one may argue that countries on the two sides of the figure have a lighter bureaucratic burden because, perhaps, the level of development is higher, or the country is endowed with more natural resources (so that the government does not need bureaucratic procedures to raise revenues), or the size of government is smaller. To address these concerns, we re-run the polynomial regression by controlling for these variables, both separately and simultaneously (all results are reported in Table A1). Specifically, we use GDP per capita to measure the level of development, natural resources rents (% of GDP) to measure the richness in natural resources, and government spending (% of GDP) to measure the size of government.[14] The coefficient of the square term is still negative and significant. Besides, a higher level of development is indeed associated with fewer bureaucratic procedures (in regressions (2) and (5)), confirming the conjecture, However, a higher endowment of natural resources is associated with *more* bureaucratic procedures (in regressions (3) and (5)), whereas a larger size of government is associated with *fewer* bureaucratic procedures (in regression (4)). The effects of the last two controls, however, are not significant.

For the tax burden, we run the regressions by controlling the same set of variables. The results, reported in Table A2, are less evident. The coefficient of the square term is still negative, but it is not significant in any of the five regressions.

Another way to see the non-monotonic nature of the empirical pattern is to use a box plot (Figures A1 and A2). We use the degree of democracy to group countries into five groups (from the lowest degree to the highest degree). In each box, the central mark is the median, the edges of the box are the 25th and 75th percentiles, the whiskers extend to the most extreme data points not considered outliers which, in turn, are plotted individually. It displays a similar inverted-U pattern as in Figures 2 and 3, although the inverted-U pattern is less pronounced in Figure A2. In the paper, we interpret the bureaucratic and tax burdens as distortionary and *substitutable* in raising government revenues. Therefore, what matters is the fact that the two burdens *together* has an

[13]The database is a self-reporting system. Data for many non-democratic countries are not available. And for some non-democratic countries included in the database, the data about property income are not provided. The sample size in Figure 4 is therefore substantially smaller than that in Figures 2 and 3.

[14]All the control variables are from the World Development Indicators, averaged over period 2005-2013.

Table A1
Effect of degree of democracy on bureaucratic burden.

Dependent variable: time cost of completing bureaucratic procedures (in years).

	(1)	(2)	(3)	(4)	(5)
degree of democracy (centered)	−0.256**	−0.100	−0.178	−0.210*	0.005
	(0.013)	(0.413)	(0.113)	(0.051)	(0.968)
degree of democracy-squared	−1.434***	−0.996**	−1.462***	−1.323***	−0.936**
	(0.000)	(0.014)	(0.000)	(0.000)	(0.023)
GDP per capital (2005 US$1,000)		−0.005**			−0.006**
		(0.046)			(0.029)
natural resources rents (% of GDP)			0.003		0.003
			(0.192)		(0.114)
government spending (% of GDP)				−0.002	0.000
				(0.689)	(0.970)
constant	1.123***	1.117***	1.095***	1.140***	1.067***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
observations	152	151	151	148	148
R-squared	0.105	0.125	0.113	0.092	0.134

p-values in parentheses
$^{***}p<0.01$, $^{**}p<0.05$, $^{*}p<0.1$

inverted-U relationship with the degree of democracy. In the model, the two burdens are then collapsed into *one* distortionary capital tax.

Finally, we address the robustness of the negative relationship in Figure 4. As before, we run the regressions by controlling the same set of variables — GDP per capita, natural resources rents (% of GDP), and government spending (% of GDP). The result is shown in Table A3. The coefficient of the degree of democracy is always negative, and it is significant in four of the five regressions. It is not significant when we control for just the natural resources rents. One may argue that countries with high returns to public capital are, perhaps, those that are endowed with more natural resources in the first place. This conjecture is confirmed by regressions (3) and (5).

A.1.3 Lump-Sum Acquisition of Public Capital

In the model, we assume that the acquisition of public capital is made in a lump-sum manner. In this subsection, we provide some partial evidence supporting this assumption.

Although it is not easy to find out where the current public capital across countries is coming from, evidence suggests that government seizure is a likely source. In the 1970s, governments seizing foreign direct investment assets is a phenomenon rather common. Figure A3 shows a negative relationship between the government seizure of foreign direct investment assets and the degree of democracy. The data are from the publication data

Table A2
Effect of degree of democracy on tax burden.

Dependent variable: effective corporate income tax (% of profits).

	(1)	(2)	(3)	(4)	(5)
degree of democracy (centered)	0.480	3.573	0.187	1.175	3.321
	(0.820)	(0.164)	(0.937)	(0.602)	(0.247)
degree of democracy-squared	−10.569	−2.540	−10.817	−10.471	−1.260
	(0.153)	(0.767)	(0.150)	(0.175)	(0.888)
GDP per capital (2005 US$1,000)		−0.112**			−0.108*
		(0.048)			(0.066)
natural resources rents (% of GDP)			−0.024		−0.027
			(0.582)		(0.544)
government spending (% of GDP)				−0.076	−0.070
				(0.499)	(0.538)
constant	17.57***	17.48***	17.86***	18.63***	18.65***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
observations	155	153	153	150	150
R-squared	0.021	0.051	0.028	0.028	0.054

p-values in parentheses
$^{***}p<0.01$, $^{**}p<0.05$, $^{*}p<0.1$

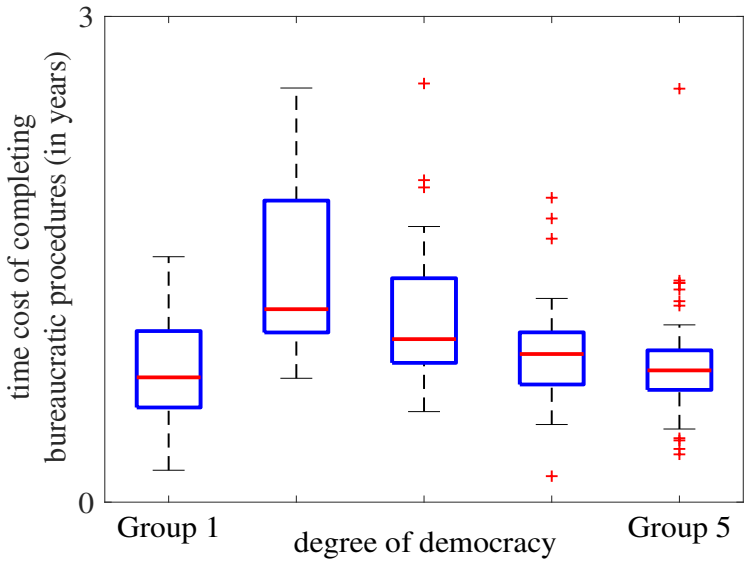
of Tomz and Wright (2010).[15] As far as we are aware of, this is also the only dataset on government seizures that allows a large-sample cross-country comparison.

The assumption that public capital acquired in a lump-sum manner is based on existing studies about the government seizure of foreign direct investment assets (e.g., Kobrin, 1980; Hajzler, 2012). The evidence suggests that seizures are concentrated in the resource and public infrastructure sectors, which are arguably sectors where sunk costs prevail. Firms in these sectors make their major investment in the early stage of business, after which government seizure only causes a mild distortion of incentives for future investment.[16]

[15]The URL is: http://web.stanford.edu/~tomz/pubs/TomzWright2010.zip. The countries are those in which U.S. citizens held direct investment at the time. The measure is obtained by counting, for each country-year observation, whether seizure by the host government occurred. It does not include government seizure of domestic assets, and it omits countries that received direct investment entirely from non-U.S. sources. Figure A3 uses data averaged over the period 1970-1979.

[16]One may argue that, if the firms had anticipated government seizure, there would have been distortion. But this reasoning only implies that, to still induce firm entry, the government should not seize assets before the sunk costs are fully compensated. Consistently, the evidence does suggest that many of the foreign firms had been operating for a substantial period before being seized.

Figure A1
Box plot of the bureaucratic burden on businesses in 152 countries, 2005-2014.



Source: *Polity IV*, World Bank's *Doing Business*.

A.1.4 Land Seizures and Resales in Contemporary China

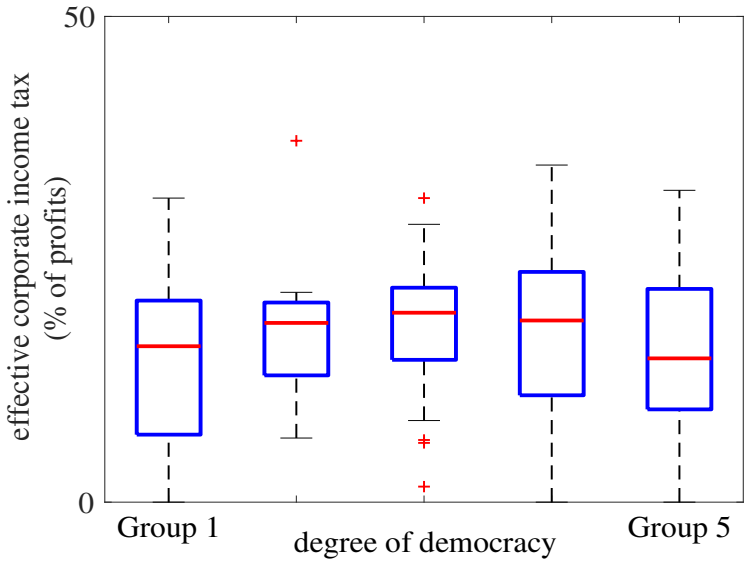
The Chinese law states that: (1) rural land is collectively owned by villagers, (2) urban land is state-owned, (3) non-agricultural sectors must use urban land, and (4) the boundary between the rural and urban areas is determined by the government. In recent decades, local governments in China seizes rural land by expanding their urban areas, compensates villagers according to the agricultural value of the seized land, and (re)sells the land-use rights to industrialists and developers.

The China Land and Resources Statistics Yearbook contains annual data on land seizures and resales (in terms of areas and revenues). Over the decade 2001-2010, the accumulated area of seized land is about 7,350 square miles, roughly the size of New Jersey or the Republic of Slovenia. Using the land sales revenues together with the government's ordinary revenues published in the China Statistical Yearbook, we plot the share of total government revenues raised by seizures and resales over time in Figure A4.

A.2 Proofs

Proof of Lemma 1 To see the necessity, substitute the first-order condition (7) into the household budget constraint (3), eliminate $\widehat{r}_{t+1}$, replace $\widehat{k}_{t+1}$ with $k_{t+1} - z_{t+1}$, and rearrange terms to obtain condition (8). To see the sufficiency, define the capital tax rate τ_{t+1} to be such that the post-policy price of capital satisfies $\widehat{r}_{t+1} = c^o_{t+1} / (k_{t+1} - z_{t+1})$. Using this expression to rearrange terms in constraint (8) yields (7) — the first-order condition of the household optimization problem. *Q.E.D.*

Figure A2
Box plot of the tax burden on businesses in 155 countries, 2013-2014.



Source: *Polity IV*, World Bank's *Doing Business*.

Proof of Lemma 2 By the standard arguments in dynamic and repeated games, it is sufficient to look at the worst subgame perfect punishment (from the politician's perspective) to characterize the best SPE allocation (in terms of welfare-maximizing). The worst punishment involves citizens replacing the politician and keeping him out of power forever. This means $c_t^{p,out} = \psi_d z_t + \phi_d (k_t - z_t)$ is the utility in the scenario of deviation. Condition (9) requires, therefore, that such utility does not exceed the continuation payoffs on the equilibrium path. *Q.E.D.*

Proof of Lemma 3 The proof resembles that of Proposition 4 in Acemoglu, Golosov, and Tsyvinski (2011).

Firstly, consider the case in which $\gamma \geq \beta$. Since a steady state is assumed to exist, (10) and (11) together implies $\lim_{t\to\infty} \lambda_t = \lambda^* < \infty$. By (14),

$$\lim_{t\to\infty} \sum_{s=0}^{t} (\gamma/\beta)^{t-s} \eta_s = \lambda^*.$$

Since $\gamma/\beta \geq 1$, it follows that $\lim_{s\to\infty} \eta_s = \eta^* = 0$. This, in turn, means (9) must be slack as $t \to \infty$.

Secondly, consider the case in which $\gamma < \beta$. Again, since a steady state is assumed to exist, $\lim_{t\to\infty} \lambda_t = \lambda^* < \infty$. In what follows, we first show that $\lambda^* > 0$. To see this,

Table A3
Effect of degree of democracy on returns to public capital.

Dependent variable: returns to public capital (% of GDP).

	(1)	(2)	(3)	(4)	(5)
degree of democracy (centered)	−5.381***	−6.099***	−1.369	−5.463***	−2.410**
	(0.000)	(0.000)	(0.206)	(0.000)	(0.035)
GDP per capital (2005 US$1,000)		0.035			0.034
		(0.222)			(0.114)
natural resources rents (% of GDP)			0.208***		0.217***
			(0.000)		(0.000)
government spending (% of GDP)				0.012	0.100
				(0.893)	(0.135)
constant	2.506***	2.028***	0.746*	2.319	−1.419
	(0.000)	(0.001)	(0.058)	(0.125)	(0.221)
observations	89	89	89	88	88
R-squared	0.163	0.178	0.548	0.164	0.580

p-values in parentheses
$^{***}p<0.01$, $^{**}p<0.05$, $^{*}p<0.1$

suppose $\lambda^* = 0$ instead. By (14),

$$\lim_{t\to\infty} \sum_{s=0}^{t} (\gamma/\beta)^{t-s} \eta_s = 0.$$

This implies, for each $0 \leq s \leq t$, $\lim_{t\to\infty} (\gamma/\beta)^{t-s} \eta_s$. In other words, $\lim_{s\to\infty} \eta_s = \eta^* = 0$. Then, in the steady state, (10) and (11) imply, by $\lambda^* = 0$, $W_{c^y} = W_{c^o} = 0$. But this equality cannot be satisfied. Therefore, we have $\lambda^* > 0$. In other words,

$$\lim_{t\to\infty} \sum_{s=0}^{t} (\gamma/\beta)^{t-s} \eta_s > 0.$$

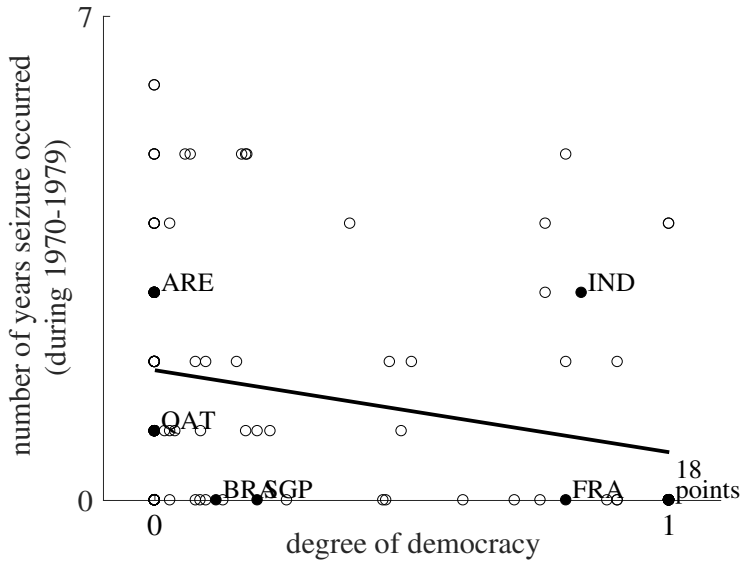
Next, we show $\lim_{s\to\infty} \eta_s = \eta^* > 0$. If not, then for any $\epsilon > 0$, there exists some $t_N > \infty$ such that, for all $t \geq t_N$, $\eta_t < \epsilon$. But then it means

$$\begin{aligned} \sum_{s=0}^{t} (\gamma/\beta)^{t-s} \eta_s &< (\gamma/\beta)^{t} \eta_0 + \cdots + (\gamma/\beta)^{t-t_N} \eta_{t_N} \\ &\quad + \epsilon \left[(\gamma/\beta)^{t-t_N-1} + (\gamma/\beta)^{t-t_N-2} + \cdots + 1 \right] \\ &< (\gamma/\beta)^{t} \eta_0 + \cdots + (\gamma/\beta)^{t-t_N} \eta_{t_N} + \frac{\epsilon}{1-\gamma/\beta}. \end{aligned}$$

For t arbitrarily large, the sum $(\gamma/\beta)^{t} \eta_0 + \cdots + (\gamma/\beta)^{t-t_N} \eta_{t_N}$ becomes arbitrarily small. Then,

$$\sum_{s=0}^{t} (\gamma/\beta)^{t-s} \eta_s < \frac{2\epsilon}{1-\gamma/\beta}.$$

Figure A3
Government seizure of FDI assets in 115 countries, 1970-1979.



Source: *Polity IV*, Tomz and Wright (2010).

Since ϵ can is arbitrarily small, this means $\lim_{t\to\infty}\sum_{s=0}^{t}(\gamma/\beta)^{t-s}\eta_s = 0$, a contradicting. Therefore, we have $\lim_{s\to\infty}\eta_s = \eta^*$, which means (9) must be binding as $t \to \infty$. *Q.E.D.*

Proof of Proposition 1 Assuming $z = 0$, the steady state is characterized by conditions

$$[c^y] \quad : \quad \frac{1}{c^y} - \frac{\mu}{c^y}\frac{k}{c^y} - \lambda = 0; \tag{A1}$$

$$[c^o] \quad : \quad \frac{1}{c^o} - \lambda = 0; \tag{A2}$$

$$[k] \quad : \quad \frac{\mu}{c^y} - \lambda + \beta\lambda f' - \beta\eta\phi_d = 0; \tag{A3}$$

$$[c^p] \quad : \quad \frac{\eta}{\lambda} = \left(1 - \frac{\gamma}{\beta}\right); \tag{A4}$$

as well as constraints

$$c^y + c^o + c^p = f(k) - k; \tag{A5}$$

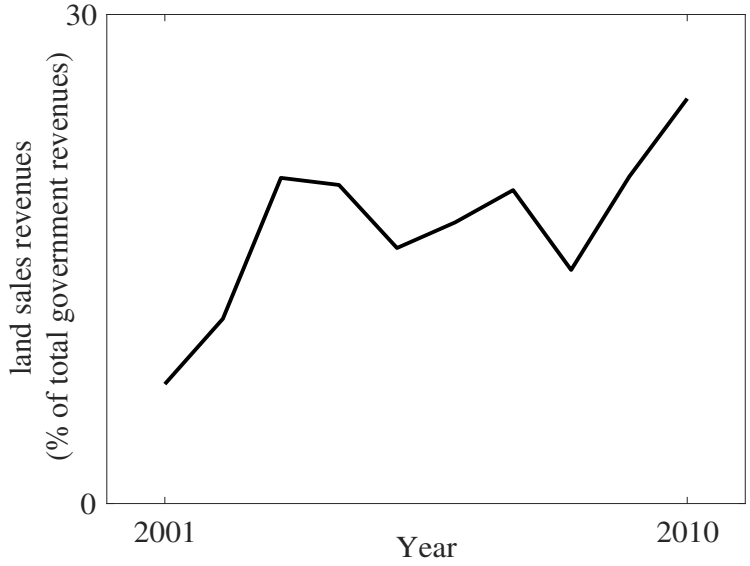
$$\beta c^y = k; \tag{A6}$$

$$\frac{c^p}{1-\gamma} = \phi_d k. \tag{A7}$$

Using (A1), (A2) and (A4) to eliminate unknowns λ, μ and η, we can rewrite (A3) as

$$\left[1 + \frac{1}{\beta} + (\beta - \gamma)\phi_d\right]\frac{1}{f'} - \frac{1}{\beta}\frac{1}{f'}\frac{c^o}{c^y} = \beta. \tag{A8}$$

Figure A4
Land sales revenues of the Chinese government, 2001-2010.



Source: *China Land and Resources Statistics Yearbook*, *China Statistical Yearbook*.

Also, using (A6) and (A7), we rewrite (A5) as

$$\begin{aligned} & c^y + c^o + c^p = f(k) - k \\ \Rightarrow \quad & \frac{c^y}{k} + \frac{c^o}{c^y}\frac{c^y}{k} + \frac{c^p}{k} = \frac{f(k)}{k} - 1 \\ \Rightarrow \quad & 1 + \frac{1}{\beta} + \frac{1}{\beta}\frac{c^o}{c^y} + (1-\gamma)\phi_d = \frac{f(k)}{k} \\ \Rightarrow \quad & \left[1 + \frac{1}{\beta} + (1-\gamma)\phi_d\right]\frac{1}{f'} + \frac{1}{\beta}\frac{1}{f'}\frac{c^o}{c^y} = \frac{1}{\alpha} \end{aligned} \tag{A9}$$

where the last step is due to the Cobb-Douglas production function. Treating $1/f'$ and $(1/f')(c^o/c^y)$ as two unknowns, we can use (A8) and (A9) to solve for $(1/f')(c^o/c^y)$, which yields

$$\frac{1}{f'}\frac{c^o}{c^y} = \beta\frac{\frac{1}{\alpha} - \beta A(\phi_d)}{1 + A(\phi_d)},$$

where

$$A(\phi_d) \equiv \frac{1 + \frac{1}{\beta} + (1-\gamma)\phi_d}{1 + \frac{1}{\beta} + (\beta-\gamma)\phi_d} > 1.$$

Since the tax rate τ in the steady state can be written as $\tau = 1 - (1/f')(c^o/c^y)$, we have

$$\tau^*|_{z=0} = 1 - \beta\frac{\frac{1}{\alpha} - \beta A(\phi_d)}{1 + A(\phi_d)}.$$

It follows that $\tau^*|_{z=0}$ is strictly decreasing in d, because $\tau^*|_{z=0}$ is strictly increasing in $A(\phi_d)$, $A(\phi_d)$ is strictly increasing in ϕ_d, and ϕ_d is strictly decreasing in d. *Q.E.D.*

PROOFS OF PROPOSITIONS 2 If $z^* > 0$ in equilibrium, the steady state is characterized by conditions

$$[c^y] \quad : \quad \frac{1}{c^y} + \frac{\mu}{c^y}\frac{z-k}{c^y} - \lambda = 0; \tag{A10}$$

$$[c^o] \quad : \quad \frac{1}{c^o} - \lambda = 0; \tag{A11}$$

$$[k] \quad : \quad \frac{\mu}{c^y} - \lambda + \beta\lambda f' - \beta\eta\phi_d = 0; \tag{A12}$$

$$[z] \quad : \quad -\frac{\mu}{c^y} - \beta\eta(\psi_d - \phi_d) = 0; \tag{A13}$$

$$[c^p] \quad : \quad \frac{\eta}{\lambda} = \left(1 - \frac{\gamma}{\beta}\right); \tag{A14}$$

as well as constraints

$$c^y + c^o + c^p = f(k) - k; \tag{A15}$$

$$\beta c^y + z = k; \tag{A16}$$

$$\frac{c^p}{1-\gamma} - (\psi_d - \phi_d) z = \phi_d k. \tag{A17}$$

Similar to the proof of Proposition 1, we use (A10), (A11) and (A14) to eliminate unknowns λ, μ and η, and we rewrite (A12) and (A13) as

$$[k] \quad : \quad -\frac{c^y}{k-z}\left(1 - \frac{c^o}{c^y}\right) - 1 + \beta f' - (\beta - \gamma)\phi_d = 0; \tag{A18}$$

$$[z] \quad : \quad \frac{c^y}{k-z}\left(1 - \frac{c^o}{c^y}\right) - (\beta - \gamma)(\psi_d - \phi_d) = 0. \tag{A19}$$

Note that (A18), (A19) and (A16) together pin down f' and c^o/c^y:

$$\begin{aligned} f' &= \frac{1 + (\beta - \gamma)\psi_d}{\beta}; \\ \frac{c^o}{c^y} &= 1 - \beta(\beta - \gamma)(\psi_d - \phi_d). \end{aligned}$$

Using $\tau = 1 - (1/f')(c^o/c^y)$, we have the tax rate τ in the steady state as

$$\tau^* = 1 - \beta\frac{1 - \beta(\beta - \gamma)(\psi_d - \phi_d)}{1 + (\beta - \gamma)\psi_d}.$$

Treating ψ as a function of ϕ, we have

$$\frac{\partial \tau^*}{\partial \phi} = \frac{\beta(\beta - \gamma)}{[1 + (\beta - \gamma)\psi]^2}\left\{[1 + \beta + \beta(\beta - \gamma)\phi]\frac{d\psi}{d\phi} - \beta[1 + (\beta - \gamma)\psi]\right\}.$$

Recall from the proof of Proposition 1 that

$$\tau^*|_{z=0} = 1 - \beta \frac{\frac{1}{\alpha} - \beta A(\phi_d)}{1 + A(\phi_d)},$$

which implies

$$\begin{aligned} \frac{\partial \tau^*|_{z=0}}{\partial \phi} &= \beta \left(\beta + \frac{1}{\alpha}\right) \frac{A'(\phi)}{[1 + A(\phi)]^2} \\ &= \frac{\beta \left(\beta + \frac{1}{\alpha}\right)(1-\beta)\left(1 + \frac{1}{\beta}\right)}{\left[1 + \frac{1}{\beta} + (1-\gamma)\phi + 1 + \frac{1}{\beta} + (\beta - \gamma)\phi\right]^2}. \end{aligned}$$

Therefore, $d\tau^*/dd > d\tau^*|_{z=0}/dd$ if and only if $\partial \tau^*/\partial \phi < \partial \tau^*|_{z=0}/\partial \phi$, which is equivalent to

$$\begin{aligned} &\frac{\beta(\beta-\gamma)}{[1 + (\beta-\gamma)\psi]^2} \left\{ [1 + \beta + \beta(\beta-\gamma)\phi] \frac{d\psi}{d\phi} - \beta [1 + (\beta-\gamma)\psi] \right\} \\ (\text{A20}) \qquad &< \frac{\beta \left(\beta + \frac{1}{\alpha}\right)(1-\beta)\left(1 + \frac{1}{\beta}\right)}{\left[1 + \frac{1}{\beta} + (1-\gamma)\phi + 1 + \frac{1}{\beta} + (\beta - \gamma)\phi\right]^2}. \end{aligned}$$

Note that the left-hand side of (A20) is strictly increasing in $d\psi/d\phi$, it approaches

$$-\frac{\beta^2(\beta-\gamma)}{1 + (\beta-\gamma)\psi} < 0$$

as $d\psi/d\phi \to 0$, and it approaches infinity as $d\psi/d\phi \to \infty$. The right-hand side is finite and positive. Therefore, there exists two thresholds M_1 and M_2 with $M_2 > M_1 > 0$ such that $\partial \tau^*/\partial \phi < \partial \tau^*|_{z=0}/\partial \phi$ if and only if $d\psi/d\phi < 1/M_1$ (or, equivalently, $\phi'_d < M_1 \psi'_d$), and that $\partial \tau^*/\partial \phi < 0$ if and only if $d\psi/d\phi < 1/M_2$ (or, equivalently, $\phi'_d < M_2 \psi'_d$). *Q.E.D.*

Proofs of Propositions 3 Recall from the proof of Proposition 2 that

$$\begin{aligned} f' &= \frac{1 + (\beta-\gamma)\psi_d}{\beta}; \\ \frac{c^o}{c^y} &= 1 - \beta(\beta-\gamma)(\psi_d - \phi_d). \end{aligned}$$

Substituting these two expressions into (A15)-(A17), we solve for the expression of z in the steady state as

$$z^* = \frac{\left[\frac{2}{\beta} - (\beta-\gamma)(\psi_d - \phi_d) + (1-\gamma)\phi_d + 1\right] k - f(k)}{\frac{2}{\beta} - (1 + \beta - 2\gamma)(\psi_d - \phi_d)}$$

where k and $f(k)$ are functions of ψ_d.

Treating ψ as a function of ϕ and taking derivative of z^* with respect to ϕ yields

$$\begin{aligned}
& \frac{\partial z^*}{\partial \phi} \frac{\left[\frac{2}{\beta} - (1+\beta-2\gamma)(\psi-\phi)\right]^2}{k} \\
= \; & B(\psi,\phi) C(\psi,\phi) \frac{1}{k}\frac{\partial k}{\partial \phi} \\
& + \left[-(\beta-\gamma)\left(\frac{d\psi}{d\phi}-1\right)+(1-\gamma)\right] C(\psi,\phi) \\
& + \left[B(\psi,\phi) - \frac{1-\alpha}{\alpha} f'(k)\right](1+\beta-2\gamma)\left(\frac{d\psi}{d\phi}-1\right),
\end{aligned}$$

where

$$\begin{aligned}
B(\psi,\phi) &\equiv \frac{2}{\beta} - (\beta-\gamma)(\psi-\phi) + (1-\gamma)\phi + 1 - f'(k); \\
C(\psi,\phi) &\equiv \frac{2}{\beta} - (1+\beta-2\gamma)(\psi-\phi).
\end{aligned}$$

Using the expression of f', we derive the expression of k as follows.

$$f' = \frac{1+(\beta-\gamma)\psi_d}{\beta} = \alpha k^{\alpha-1} \Rightarrow k = \left(\frac{1}{\alpha}\frac{1+(\beta-\gamma)\psi_d}{\beta}\right)^{\frac{1}{\alpha-1}}.$$

Consequently,

$$\frac{1}{k}\frac{\partial k}{\partial \phi} = -\frac{\beta-\gamma}{1-\alpha}\frac{1}{1+(\beta-\gamma)\psi}\frac{d\psi}{d\phi}.$$

Also note that $C(\psi,\phi) > B(\psi,\phi) > 0$.

Therefore, $\partial z^*/\partial\phi > 0$ if and only if

$$\begin{aligned}
0 \; < \; & -B(\psi,\phi) C(\psi,\phi) \frac{\beta-\gamma}{1-\alpha}\frac{1}{1+(\beta-\gamma)\psi}\frac{d\psi}{d\phi} \\
& + \left[-(\beta-\gamma)\left(\frac{d\psi}{d\phi}-1\right)+(1-\gamma)\right] C(\psi,\phi) \\
& + \left(B(\psi,\phi) - \frac{1-\alpha}{\alpha} f'(k)\right)(1+\beta-2\gamma)\left(\frac{d\psi}{d\phi}-1\right),
\end{aligned}$$

which can be rewritten as

$$\begin{aligned}
0 \; < \; & \frac{1+\beta-2\gamma}{\beta-\gamma}\left(B(\psi,\phi) - \frac{1-\alpha}{\alpha} f'(k)\right)\frac{d\psi}{d\phi} \\
& -B(\psi,\phi) C(\psi,\phi) \frac{1}{1-\alpha}\frac{1}{1+(\beta-\gamma)\psi}\frac{d\psi}{d\phi} \\
& -C(\psi,\phi)\frac{d\psi}{d\phi}
\end{aligned}$$

$$+\frac{1+\beta-2\gamma}{\beta-\gamma}\left(C\left(\psi,\phi\right)-B\left(\psi,\phi\right)+\frac{1-\alpha}{\alpha}f'\left(k\right)\right).$$

Note that the right-hand side of the above inequality, a function of $d\psi/d\phi$, has a slope with an ambiguous sign and a positive intercept. If the slope is positive, the inequality always holds, which means $\partial z^*/\partial\phi > 0$ always holds. If the slope is negative, then there exists a threshold $N > 0$ such that $\partial z^*/\partial\phi > 0$ if and only if $d\psi/d\phi < 1/N$ (or, equivalently, $\phi'_d < N\psi'_d$). Therefore, regardless of the sign of the slope, $d\psi/d\phi < 1/N$ is a sufficient condition for $\partial z^*/\partial\phi > 0$ (or, equivalently, $dz^*/dd < 0$). *Q.E.D.*

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