# The co-development of economies and institutions

**Dawei Che and Ling Shen**[1]

## Abstract

In this paper, we cast the Schumpeterian growth theory in a simple discrete-time framework where both economy and institutions need to be developed. In order to develop an economy, individuals need to borrow from an imperfect financial market. Hence, a government adopts two potential strategies for improving the borrowing capacity of individuals and, in turn, enhancing economic performance: “the rule by law” and “industrial policies.” Thus, we interpret market-oriented reform in transition economies as shift from “industrial policies” to “the rule by law.” The model reveals that both strategies could be the best choice in different development stages.

**Keywords:** Institutional reform, political transition, economic growth, innovation, political economy, technology progress.

**JEL Classification Numbers:** O11, O16, O31, O43, P16, P26, L16

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## 1. Introduction

Today, there is no doubt that market-oriented reform is one of the main engines of Chinese fast economic growth in last three decades. For instance, the employees who work in private enterprises in China grow from zero in 1978 to 294 million in 2009, roughly 37.8% of the total labor force.[2] However, some economists noticed the puzzling attitude of Chinese government to private enterprises and free markets. For instance, Song et al. (2011) argues that the Chinese banking system is almost closed for private enterprises and only open to state-owned enterprises (SOEs). It seems that, on one hand, the Chinese government had begun privatization since 1980s and, on the other, was implementing policies and institutions favorable to state-owned enterprises. If the Chinese government would recognize that private enterprises are more efficient than SOEs, such policies favoring SOEs would vanish in the short term. However, according to Song et al. (2011), we cannot come to this conclusion. If the Chinese government believed that it was necessary to support SOEs by such non-competitive arrangements in order to enhance economic growth, why did it initiate reform at the beginning of the 1980s?

Chinese imperfect financial market is one example of non-competitive policies and institutions, which have been well documented for a long time in the literature (e.g., Gerschenkron [1962, p. 7] and Acemoglu et al. 2006). However, previous studies emphasize the feature of "investment-based growth." (Acemoglu et al. 2006) We find that such "long relationships between firms and banks, as well as large firms and state intervention" often are biased *de facto* toward certain enterprises. Thus, we characterize these industrial policies as "partial protecting strategy".[3] A centrally planned system is just the extreme case of this strategy. In such economies, some industries are state-owned and, thus, obtain a large amount of resources (not only a better access to credit markets), e.g., the military and steel industries that are the first priority in the former Soviet Union and China. However, others are not, e.g., agriculture in China.[4] Although currently China has made great progress toward a market economy, there are still many subsidies, trade barriers, and entry barriers, most of which are biased toward SOEs.[5] In general, these industrial policies can be found in many non-centrally planned economies (e.g., Japan and South Korea) in their initial stages of development. Most protected firms in Japan and South Korea are private enterprises. Thus, we measure the industrial policies (partial protecting strategy) by the number of protected enterprises, denoted by PPEs.

On the opposite, a government in market economy establishes a system of law, which extends economic freedoms and protects property rights equally for all individuals. Thus, it is referred to as "general protecting strategy". Economists generally agree that the rule of law is the fundamental reason for innovation and

[2] According to Chinese statistic yearbook 2010.

[3] The feature that only a few enterprises can obtain support from the government is the key aspect of such non-competitive arrangements. We owe this term to Shen (2007), in which the group-specific subsidy is the key tool of the ruler for enhancing economic growth.

[4] Such partial protecting strategy is well recorded by economists (e.g., Roland 2000) and recognized as a failure of development strategy (e.g., Yifu Lin 2003).

[5] This is the potential reason why WTO does not recognize the Chinese market economy position. Many economists concentrate on induced distortion (e.g., Hsieh et al. 2009).

investment, which, in turn, is the reason for long-term economic growth (Barro 2001). Since most developing countries are dictatorial in some sense, it is hard to find the real rule of law in those countries. However, we did find the rule by law in Singapore, HK, and South Korea before 1990. Since the rule by law is necessary for a well-functioning market economy[6], we can interpret the market-oriented reform as an improvement of the rule by law, as well as decreasing the number of PPEs in our simple model. This is a little different from the traditional transition economics that mainly concentrates on privatization. However, new literature has already shed some light on the rule of law (e.g., Hoff et al. 2004).

Since industrial policies induces numerous distortions, which have already been mentioned in the literature (Hsieh et al. 2009, Song et al. 2011, Buera et al. 2011), it is of interest to ask why those countries, for instance, China, choose industrial policies instead of the rule by law in the initial stages of development and then switched to the latter in a more advanced stage. Furthermore, it is also of interest to show why the Chinese government has such a puzzling attitude to private enterprises, which induces a zigzag way to market economy. Since 1980s, we can observe a general privatization in China and at the same time, there are numerous policies and institutions favorable to SOEs (the financial imperfections mentioned by Song et al. 2011 is just an example), which in turn, lead to a tendency called "SOEs forwards and privatization retreats" (*Guojin Mintui* in Chinese) in some sectors.

The main task of this paper is to present a rationale for the endogenous institutional transition along with the economic growth path in developing economies. We want to argue that certain institutions (here, industrial policies) that might initially increase growth could subsequently lead to slower growth. In other words, we need to develop a unified theory to explain the process of the co-development of economy and institutions.

Our main results are based on the following assumptions: (i) We assume that for a developing economy, it is costly to establish a proper institution, either the rule by law or industrial policies.[7] For simplicity, we assume that the endowment of a government for the development of institutions is constant, denoted as "effort." This is a political power which market actors (e.g., the financial market, firms) have not. Hence, the evolution of institutions is determined by the optimal allocation of the government's effort in different stages of development. (ii) Economic development depends on investment in R&D, which need to be financed in an imperfect financial market.[8] The borrowing capacity of individuals depends on their own endowment (the wage income, related to technology level) and the imperfectness of financial market, which, in turn, depends on the rule by law. (iii) Industrial policies are modeled by

[6] Some economists use Lee Kuan Yew in Singapore or Park Chung-Hee in South Korea as paragons of free markets and the rule by law, while others cite them as interveners using massive industrial policies (here, partial protecting strategy). Our model shows that both are optimal options in different stages of development.

[7] Hoff et al. (2004, 2008) reveal how difficult it can be for a society to establish the rule by law. The traditional idea that the financial market is more efficient than government needs an assumption which the rule by law is already set up, which is just what we want to emphasize.

[8] Here we follow Aghion et al. (2005) to assume a credit market. Including other form of financing, e.g., equity financing, does not change our main conclusion, because it also needs the rule by law. Hence, the financial market in this paper could be understood as a general defined resource which could support economic growth with the rule by law.

government insurance[9]. Once the government guarantees an enterprise's credit, the enterprise can borrow any amount[10] that it needs. However, it is not a free lunch for the government to supply such insurance. The cost is the effort which the government has to spend in order to monitor the firms with government insurance.[11] Because firms borrow from financial market with government insurance, if they default, the government has to pay by itself. Furthermore, the cost of such guarantees increases disproportionately to the number of PPEs. Hence, industrial policies are relatively easy to begin, and their benefit is relatively large in the early stages of development. In contrast, the rule by law brings little benefit in the initial stages because individuals are poor and have little to mortgage. A Ramsey government is willing to choose industrial policies to promote economic growth in the initial stages of development. As the economy evolves, the cost of industrial policies becomes increasingly large; consequently, it is cost-effective for the government to establish the rule by law.

The puzzling attitude of the Chinese government to private enterprises can be understood if we slightly extend the basic model by introducing a fixed cost in the above R&D investment. Then the transition path is no longer smooth in the short run. Due to fixed costs, unprotected enterprises are not willing to invest when their incomes are low. The government begins to improve the rule by law in order to induce unprotected enterprises' investments in innovation. Since individuals are still poor and do not have sufficient income for mortgage payments, the government has no incentive to improve the rule by law so much that unprotected enterprises' investment is much higher than their fixed costs. During this period, unprotected enterprises do make investments; however, their investments are kept at a minimal level (just a little more than fixed costs). Thus, their profits are small. The benefit from economic growth induced by unprotected enterprises' investments is used to support an increasing number of PPEs. Only if the economy grows further and reaches certain threshold values is the government willing to invest in the rule by law again. Furthermore, we show that the government prefers to support more PPEs in an industry whose fixed costs are higher.

The other extension is in keeping with political-economy models by assuming a non-Ramsey government, which is more concerned with PPEs than with non-PPEs. Thus, there is a slightly more pessimistic process of transition than that described above. A *de jure* biased-to-PPEs government begins reform by reducing the number of PPEs when certain conditions are satisfied. However, with economic growth, the government reverts to partial protecting strategy. This implies that the positive

[9] In China, the government hardly lends directly to firms, even to SOEs. The government often claims that it has not enough money, hence, even some public goods, e.g., universities, high ways and high-speed railways are built by loans from banking system. What the Chinese government exactly does is to give some selected firms an implicit insurance, and then Chinese banking system is willing to lend money to them. These selected firms are at most, but not necessary SOEs.

[10] It is not necessary to assume that PPEs can borrow "any amount" through government guarantee. However, a government guarantee does ensure that PPEs can borrow more than their own borrowing capacities would otherwise allow.

[11] We do not assume that the government is more efficient than the financial market to find the specific firms which will not default. In our model, all firms will default if defaulting cost is low enough. We do assume that once the government monitors PPEs, they can not default. The monitoring cost of the government is in units of effort. We can imagine that the effort is the number of policemen. If many policemen are allocated around PPEs, then it is safe for banks to give loans to them.

gradualism reform in China could be a transitory phenomenon. The "Big Bang" strategy is dominant in this sense because it eliminates the possibility of bias toward PPEs in the short term.

The present paper connects two different strands of the literature. First, the literature of transition economics sheds light on this transition process from an inefficient institution (i.e., a centrally planned economy) to an efficient one (i.e., a market economy) (see Murphy et al. 1992, Roland 2000, Lau et al. 2000). Most studies focus on the process of privatization and compare the Big Bang strategy (e.g., the former Soviet Union and other East European countries) and gradualism (e.g., China). And others emphasize the role of the rule of law (e.g., Hoff et al. 2004, 2008). While we do not dispute that inefficient institutions need to be abandoned today, the question is why did they emerge in history.

The other strand of literature belongs to development economics and political economy. They emphasize that the underlying reasons for economic divergence worldwide are institutional barriers in developing economies. Some political economy models explain why better foreign technologies are blocked by domestic vested interest cliques (e.g., Parente et al. 2000, Acemoglu et al. 2000, and Acemoglu 2005). Others shed light on the persistence of a lawless state, which in turn, impedes innovation and investment, thereby inducing economic stagnation (e.g., Aghion et al. 2005, Hoff et al. 2008). Again, too few studies have addressed the question of why an inefficient institution (here, the partial protecting strategy) was established in an early stage of development, only to be abandoned after a few decades.

Although there are few studies in the literature that have investigated institutional switching along with economic growth, to our limited knowledge, the study of Acemoglu et al. (2006) is an exception. It focuses on switching policies from an investment-based strategy to an innovation-based one. Their first strategy is consistent with our industrial policies (the partial protecting strategy), and the second is similar to the rule by law. However, the engine of switching in their model is the distance to the world technology frontier. The switch occurs only if the distance is sufficiently small so that innovation, instead of imitation, becomes the main source of economic growth. The cost of establishing institutions plays no role in their framework. Our main results rely on the cost-benefit analysis of government in different stages of development. Although our switch of institutions is also linked with economic performance, it is not necessary that the economy choosing the rule by law be innovation-based. It is more consistent with market-oriented reforms in former centrally planned systems, either in China or former Soviet Union. These economies achieved high economic growth rates in the early stages of development and began reform in the 80s and 90s of the last century. At that time, the distance between these countries and the world technology frontier was huge one. Furthermore, the main engine of growth in China has seemed to be "imitation" but not "innovation." Hence, our model provides another reasonable interpretation for the institutional switch.

The other similar study investigating endogenous institutions and policies is that of Wang (2010). However, his work concentrates on the stepwise process from an inefficient institution to an efficient one with economic growth. He did not show the other side of inefficient institutions or explain why such institutions should be established. Furthermore, his model is fully established on the basis of a Ramsey government; hence, our result of a zigzag and/or transitory reform process is not included in his work.

The remainder of the paper is organized in the following manner. Section 2 outlines the basic model. Section 3 extends a fixed cost in investments. Section 4 discusses a *de jure* biased-to-PPEs government. Section 5 presents the conclusion.

## 2. The basic model

Here, we follow Aghion et al. (2005) in casting Schumpeterian growth theory in a simple discrete-time framework.[12] We consider an economy with two types of players: one is a continuum $L$ of citizens each with one unit of labor force; the other is a government who has one unit of effort, which can be used to improve institutions and is denoted by $E$. Citizens are assumed to live in two periods. In the first period, they supply labor to produce general goods; their income is in the form of a wage $w_{1t}$, which can be used to consume and/or invest. In the second period, citizens do not work and their income is the return on investment from the first period, denoted by $w_{2t+1}$. The utility function is linear: $u_t = c_{1t} + \beta c_{2t+1}$ $\beta \in (0,1)$; thus, individuals are indifferent between saving and consumption.

There are two types of products in the economy, the multipurpose "general" good (which we use as the numéraire) and intermediate goods. The general good is produced by labor and a continuum of intermediate goods according to the production function:

$$Y_t = L^{1-\alpha} \int_0^1 (A_t(i))^{1-\alpha} (x_t(i))^{\alpha} \, di , \tag{1}$$

where $x_t(i)$ is the quantity of intermediate good $i$, and $A_t(i)$ is its productivity. For the sake of simplicity, we follow Aghion et al. (2005) and assume $L = 1$. The productivity $A_t(i)$ evolves according to:

$$A_{t+1}(i) = \begin{cases} \overline{A}_{t+1} & u_t \\ A_t(i) & 1-u_t \end{cases} , \tag{2}$$

where $u_t$ is a probability of innovation, and $\overline{A}_{t+1}$ is the world technology frontier, which grows at the constant rate $g > 0$. We define $A_t = \int_0^1 A_t(i) di$, which is average productivity, and $a_t = A_t / \overline{A}_t$, which measures the distance to the technology frontier.

[12] We just follow their framework till "institution" in page 8, and simplify some calculations. For detail deductions, see Aghion et al. (2005).

The evolution of $a_t$ is according to the following equation:

$$a_{t+1} = u_t + \frac{1-u_t}{1+g} a_t \,. \tag{3}$$

After successful innovation,[13] sector $i$ has an incumbent, who can transfer one unit general good to one unit intermediate good. Hence, the marginal cost is 1. In addition, there are an unlimited number of people who can copy the latest version of that intermediate good at a cost $\chi > 1$. Hence, regardless of whether innovation succeeds, the price of intermediate goods is $\chi$. A successful innovator can earn a positive profit $\chi - 1$ in one period, whereas in non-innovating sectors production is undertaken under perfect competition. It follows that an unsuccessful innovator will earn zero profit in the next period, and the profit of a successful innovator is

$$\pi_t = (\chi - 1)\left(\frac{\alpha}{\chi}\right)^{\frac{1}{1-\alpha}} \bar{A}_t = \pi \bar{A}_t \,. \tag{4}$$

In the first period, the wage rate is given by the marginal products. Hence, we obtain:

$$w_{1t} = (1-\alpha)Y_t = (1-\alpha)\left(\frac{\alpha}{\chi}\right)^{\frac{\alpha}{1-\alpha}} A_t \equiv (1-\alpha)\zeta A_t \,, \tag{5}$$

where $\zeta = (\alpha/\chi)^{\frac{\alpha}{1-\alpha}}$. Hence, per capita GDP is $Y_t = w_{1t} + u_t \pi_t$, which is equal to

$$Y_t = \bar{A}_t \left((1-\alpha)\zeta a_t + u_t \pi\right). \tag{6}$$

GDP is proportional to the technology frontier $\bar{A}_t$, which represents the spillover effect. On the other hand, it is subject to the technology gap $a_t$, which, in turn, depends on R&D investments. Therefore, a developing country that aims to catch up with the world technology frontier has great incentive to maximize $u_t$.

**Innovation**

Apart from working as a laborer, citizen $i$ invests R&D ($N_t(i)$) in sector $i$ in the first period. The probability of a successful innovation $u_t$ depends on the

[13] Here, we follow Aghion et al. (2005) to call it "innovation." However, we realized that such innovation is a kind of "imitation" in Acemoglu et al. (2006). A backward economy can catch up with the world frontier only with a probability smaller than 1, which means that, on average, the technology level of backward economies cannot catch up with the world frontier by such "imitation." If a developing economy does not invest in such "imitation," its technology gap will become larger because the world frontier grows constantly.

investment ratio, $n_t = \frac{N_t}{\bar{A}_{t+1}}$, which implies that catching-up is more difficult the higher the new technology frontier. We assume that $u(n_t)$ satisfies $u(\infty) \to 1$, $u(0) = 0$, $u' > 0$ $u'' < 0$. In a perfect credit market, an individual simply maximizes his/her expected profit:

$$u_t \pi_{t+1} - RN_t. \tag{7}$$

where R is the interest rate[14]. Substituting (4) we have the following optimization problem:

$$\max_{n_t} \left( \pi u(n_t) - Rn_t \right) \bar{A}_{t+1}. \tag{8}$$

In order to ensure an interior solution, we make the following assumption:

**Participation assumption:** $\pi u'(0) \geq 1/\beta$.

Under the participation assumption, individuals are willing to invest in R&D. The FOC is $\pi u'(n^*) = 1/\beta$. Hence, the optimal investment ratio is independent on the technology gap. Individual $i$ borrows from financial markets if her income $w_{1t}$ is smaller than $n^* \bar{A}_{t+1}$, which implies that $a_t < \frac{n^*(1+g)}{(1-\alpha)\zeta}$. For a developing economy, the technology gap $a_t$ is always small enough. Hence, catching-up often needs a well-functioning financial market.

**Status quo assumption:** $a_0 < \frac{n^*(1+g)}{(1-\alpha)\zeta}$

Intuitively, the larger the technology gap, the higher the growth rate if there is a perfect financial market. This is consistent with the “advantage of backwardness” (Gerschenkron 1962).

**Imperfect financial market**

Although financial markets are necessary for economic growth in developing economies, these markets are not well developed in such economies. If financial markets are not perfect, a borrower can defraud if she pays a cost $cN_t$, where $0 < c < R$. Hence, the condition of non-defrauding is

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14 Combining utility function we know that $\beta R = 1$.

$$cN_t \geq R(N_t - w_{1t}). \quad (9)$$

Therefore, an individual cannot invest more than

$$N_t^{\max} = \frac{R}{R-c} w_{1t}. \quad (10)$$

Further, he/she cannot borrow more than $\frac{c}{R-c} w_{1t}$ from imperfect financial markets. Since $\frac{c}{R-c}$ increases in $c$, the lesser the financial markets develop, the fewer are the R&D investments, and in turn, the lower the innovation rate. For $c \to 0$, the individual definitely defrauds. Hence, nobody is willing to lend money to this individual. Therefore, $N_t^{\max} \to w_{1t}$ (i.e., the individual cannot finance with help from financial markets). For $c \to R$, he/she cannot defraud. Hence, financial markets approach perfectness. If there is no binding constraint, then she invests $n^* \overline{A}_{t+1}$. This credit constraint is binding if the unconstrained optimal investment is strictly greater than the innovator's borrowing capacity:

$$n_t^* \overline{A}_{t+1} > \frac{R}{R-c} w_{1t} \Leftrightarrow n_t^* > \frac{R(1-\alpha)\zeta}{(R-c)(1+g)} a_t \equiv \omega(c) a_t, \text{ where } \frac{\partial \omega}{\partial c} > 0. \quad (11)$$

**Institutions**

We assume that there is a benevolent government that wants to maximize the technology level or minimize the technology gap.[15] This assumption is consistent with Lin's (2003) concept. It could be argued that most developing countries have a dictatorial government (e.g., Shen 2007). Hence, it is not natural to assume them to be benevolent. However, even for a dictator, social welfare (here, it is equivalent to the technology level) is not something that can be entirely neglected—in particular, when it has "encompassing interest" (McGuire et al. 1996). We introduce a benevolent government as a benchmark and then extend the model in section 4 to include a government that is slightly biased toward PPEs.

The government makes an effort $E$, which can be employed in the following two ways:

1) **The rule by law.** In order to improve financial markets, the government invests $b_t$ in the rule by law (c rises).[16] When c rises, for all investors, the constraint $\omega(c) a_t < n^*$ releases in equal measure. In the early stages of development, the government is probably not able to improve the rule by law to such an extent that c

[15] Because of the linear utility function (p.6), individuals want to maximize their income, which is fully determined by the technology level. Hence, a government is able to affect R&D investment, which determines the technology level in the next period.

[16] Here, we consider an institution with a static nature for simplicity. In general, a dictatorial government in developing countries has the political power to set up a law system, as well as destroy it in short time, for instance, China. We can interpret $b_t$ as the expenditure on policemen in each period. If it decreases, $c_t$ rises.

becomes sufficiently large to release the constraint for all. Rearranging $\omega(c)a_t < n^*$, we have a threshold value for c, only if the institutional investment is so large that c is greater than $\tilde{c} \equiv R\left[1-\frac{(1-\alpha)\zeta}{n^*(1+g)}a_t\right]$, and then individuals invest $n^*$.

Let us assume that $c_t = c(b_t)$, where $c(0)=0 \quad c(\infty)=R$, $c'(b)>0 \quad c''(b)<0$. Hence, the institutional investment in the rule by law has a normal production function (i.e., diminishing marginal products). For simplicity, we assume $c(b)=\frac{b}{b+1}R$; substituting this in (10), we obtain $N_t^{\max}=(b_t+1)w_t$ (i.e., the maximal R&D investment increases in the investment of government under the rule by law). Hence,

$$n_t^{\max} \equiv N_t^{\max} \Big/ \bar{A}_{t+1} = \frac{(1+b_t)(1-\alpha)\zeta A_t}{\bar{A}_{t+1}} = \frac{(1+b_t)(1-\alpha)\zeta a_t}{1+g}. \qquad (12)$$

Let $\omega \equiv \frac{(1-\alpha)\zeta}{1+g}$, we have $n_t^{\max} = (1+b_t)\omega a_t$.

2) **Industrial policies.** In order to encourage private R&D investments, it is not necessary for the government to establish the rule by law. It can help a portion of the population to borrow sufficient money and invest in R&D. Let us assume that the population share of individuals who can obtain support from the government is $\lambda_t$. Once they are supported by the government, they can finance their investments at the optimal level; consequently, their innovation rate is $u^*$. The other unprotected citizens are called "non-PPEs," whose innovation rate is denoted by $\tilde{u}$. The cost of government support is $d_t = d(\lambda_t)$, where $d(0)=0$, $d'(0)=0$, $d'(\lambda_t)>0 \quad \forall \lambda_t > 0$, $d''(\lambda_t)>0 \quad \forall \lambda_t \geq 0$. It must be noted that the costs of establishing the two institutions are similar: $b'(0)= 1/R \; vs. \; d'(0)=0$ and $b''>0 \; vs. \; d''>0$. This implies that the development of any type of institution is expensive. However, the benefits to both institutions are different in the initial periods: the benefit of the rule by law depends on the initial income of individuals; hence, it is relatively small when the economy is poor. However, the benefit of industrial policies is independent of the initial income. Hence, it is not beneficial for the government to make the choice of establishing the rule by law in the early stages of development.

The optimization problem of government is given in the following manner:

$$\underset{b_t \geq 0, \lambda_t \geq 0}{Max}\{A_{t+1}\} \quad s.t. \quad b_t + d(\lambda_t) = E. \qquad (13)$$

We define $\bar{\lambda} \equiv d^{-1}(E)$, which is the maximal number of PPEs when the government invests everything in industrial policies and nothing in the rule by law. Then (13) is equal to

$$\max_{\lambda_t}\left\{\lambda_t\left[u^*\bar{A}_{t+1}+(1-u^*)A_t\right]+(1-\lambda_t)\left[\tilde{u}\bar{A}_{t+1}+(1-\tilde{u})A_t\right]\right\}, \tag{14}$$

$$\text{s.t.}\ \tilde{u}=u\left[(E-d(\lambda_t)+1)\omega a_t\right]\ and\ 0\le\lambda_t\le\bar{\lambda}\ .$$

Again, (14) is equivalent to the maximization of the technology gap in the next period:

$$a_{t+1}=\left\{\lambda_t\left(u^*+(1-u^*)\frac{a_t}{1+g}\right)+(1-\lambda_t)\left(\tilde{u}+(1-\tilde{u})\frac{a_t}{1+g}\right)\right\}; \tag{15}$$

$$\text{FOC:}\ \frac{da_{t+1}}{d\lambda_t}=\left[u^*-\tilde{u}+(1-\lambda_t)\frac{d\tilde{u}}{d\lambda_t}\right]\left(1-\frac{a_t}{1+g}\right)=0\,. \tag{16}$$

Because $a_t<1+g$, (16) is equal to $u^*=\tilde{u}-(1-\lambda_t)\frac{d\tilde{u}}{d\lambda_t}$. The left-hand side of the above equation is the benefit received by increasing one unit of $\lambda$[17], whereas the right-hand side is the cost. Further, $\tilde{u}$ is the innovation rate of non-PPEs—i.e., increasing one unit of PPEs implies reducing one unit of non-PPEs; $-(1-\lambda_t)\frac{d\tilde{u}}{d\lambda_t}$ is the reduction in the innovation rate for all non-PPEs due to fewer investments in the rule by law. For the sake of convenience, we define the cost function as $G(\lambda_t,a_t)=\tilde{u}-(1-\lambda_t)\frac{d\tilde{u}}{d\lambda_t}$. The interior solution $\lambda^*(a_t)$ satisfies $G\left(\lambda^*(a_t),a_t\right)=u^*$.

**Lemma 1:** *Given assumption：1)* $-\frac{u''(\bullet)}{u'(\bullet)}<\frac{1}{(1+E)\omega}$ *and 2)* $\frac{d''(\bullet)}{d'(\bullet)}>\frac{2}{1-\bar{\lambda}}$, *we obtain:* $G_\lambda>0, G_a>0$.

**Proof:** see Appendix 1.

Intuitively, $-\frac{u''(\bullet)}{u'(\bullet)}$ represents the curvature of innovation function $u(\bullet)$, and

[17] Here, the benefit of increasing one unit of $\lambda$ is just $u^*$ because we assume PPEs can borrow at the optimal level $n^*$. If we release our assumption to let PPEs be slightly inefficient, as most of the existing literature argues, we can assume their innovation rate is $\psi u^*\ \forall\psi<1$. Then there should be a threshold value of inefficiency, if $\psi$ is not too big, our main results do not change qualitatively.

$\frac{d''(\bullet)}{d'(\bullet)}$ is the curvature of the cost function of industrial policies. Both assumptions ensure that the curves are bending enough so that the cost of industrial policies increases in the number of PPEs and the technology level. It implies that industrial policies will not be optimal in the advanced stages.

**Proposition 1:** *We define a certain value of technology gap* $a^2 \equiv \frac{n^*}{(1+E)\omega}$. *There exists a threshold value* $\tilde{a} < a^2$, *so that* $\lambda^*(\tilde{a}) = \bar{\lambda}$.

*1) For* $a_t \leq \tilde{a}$, *the optimal No. of PPEs is* $\bar{\lambda}$;

*2) For* $\tilde{a} < a_t \leq a^2$, *the government chooses* $\lambda_t^* = \lambda^*(a_t)$, *which satisfies* $\lambda^{*\prime}(a_t) < 0$ *and* $\lambda^*(a^2) = 0$.

*3) For* $a_t > a^2$, *the government chooses* $\lambda_t^* = 0$.

**Proof:** See Appendix 2 and figure 1.

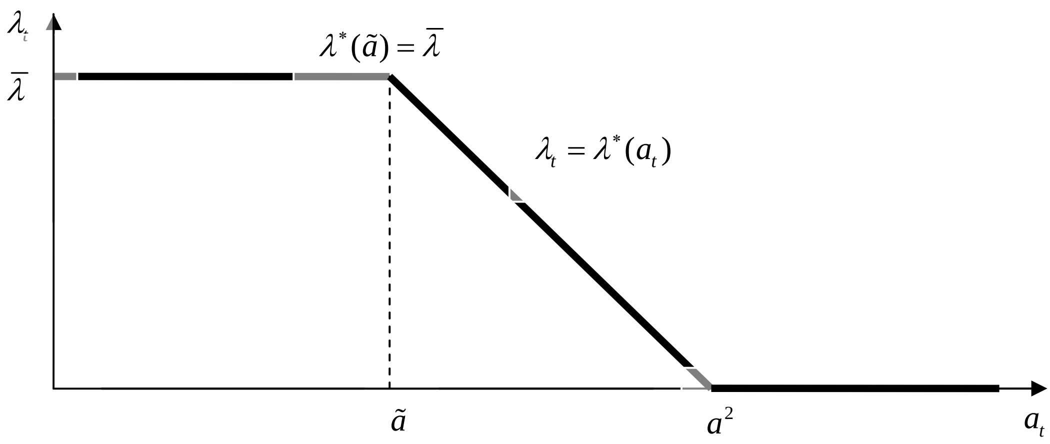


**Figure 1**

Figure 1 presents the implication of the above proposition. A backward economy needs industrial policies to trigger the initial growth in very early stages of development. When $a_t \leq a^2$, $a_t$ is so small that even government invests all efforts in the rule by law, the maximal R&D investment of individuals financed by credit markets cannot exceed the unconstrained optimal level $n^*$. Furthermore, the effect of the rule by law is subject to technology. The lower the level of technology, the lesser is the increase in borrowing capacity when the rule by law is improved. This implies that the government is not willing to invest all efforts in the rule by law in the early stages of development. However, if the government implements industrial policies, it can induce some individuals to invest at the optimal level. Hence, industrial policies can generate a higher innovation rate in aggregate than the rule by law in the early stages of development. In particular, if $a_t \le \tilde{a}$, the government invests all efforts to protect PPEs. In this case, the evolution equation of $a_t$ is given by[18]

$$a_{t+1} = \bar{\lambda}\left[u^* + (1-u^*)\frac{a_t}{1+g}\right] + (1-\bar{\lambda})\left[\tilde{u}(\omega a_t) + (1-\tilde{u}(\omega a_t))\frac{a_t}{1+g}\right]. \qquad (17)$$

In the second case, $\tilde{a} < a_t \le a^2$, government implements market-oriented reform by reducing the number of PPEs and investing in the rule by law. As a result, the growth rate of the economy increases.[19]

$$a_{t+1} = \lambda^*(a_t)\left(u^* + (1-u^*)\frac{a_t}{1+g}\right) + (1-\lambda^*(a_t))\left(\tilde{u}(a_t) + (1-\tilde{u}(a_t))\frac{a_t}{1+g}\right). \qquad (18)$$

With the increase in $a_t$, failed enterprises in terms of innovation have a higher technology level ($a_t/(1+g)$), which increases the level of aggregate technology. At the same time, the increase in $a_t$ improves the income of individuals, which implies that they can borrow more from financial markets, which, in turn, increases their innovation rates ($\tilde{u}(a_t)$). This further accelerates the progress in technology. If the economy eventually enters into the third case, where the government establishes the entire system of law, there are no PPEs. This could be interpreted as a market economy. Then the evolution equation of the technology gap is given as

$$a_{t+1} = u^* + \frac{1-u^*}{1+g}a_t. \qquad (19)$$

The steady state is

$$a^{2*} = \frac{u^*(1+g)}{u^*+g}. \qquad (20)$$

We find that even in the third case, where the law system is established, the

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[18] It is easy to see that $a_{t+1}'(a_t) > 0$ and $a_{t+1}''(a_t) < 0$. Hence, there is, at most, one steady state—$a^{1*}$. However, it is not very clear whether $a^{1*} < \tilde{a}$.

[19] It is easy to see $\frac{da_{t+1}}{da_t} > 0$. Due to the envelope theorem, we obtain

$$\frac{da_{t+1}}{da_t} = \frac{d\lambda^*}{da_t}\left(\frac{\partial a_{t+1}}{\partial \lambda^*} + \frac{\partial a_{t+1}}{\partial \tilde{u}}\frac{\partial \tilde{u}}{\partial \lambda^*}\right) + \frac{\partial a_{t+1}}{\partial \tilde{u}}\frac{\partial \tilde{u}}{\partial a_t} + \frac{\partial a_{t+1}}{\partial a_t} = \frac{\partial a_{t+1}}{\partial \tilde{u}}\frac{\partial \tilde{u}}{\partial a_t} + \frac{\partial a_{t+1}}{\partial a_t} > 0.$$

steady state is still smaller than 1 ($a^{2*} < 1$). This is because our assumed innovation is in fact an "imitation." The success of innovation brings enterprises closer to the world frontier, while the failed stay behind the frontier. Hence, on average, a backward economy cannot catch up with the world frontier (i.e., $a^{2*} = 1$) through "imitation." Our model can be extended to include true "innovation"; however, it does not qualitatively change our results regarding the switching of institutions[20].

**3. Innovation with a fixed cost**

We now extend our basic model by introducing a fixed cost in the innovation investment; that is,

$$u(n_t) = \begin{cases} 0 & if \quad n_t \le \bar{n} \\ > 0 & if \quad n_t > \bar{n} \end{cases}. \tag{21}$$

Furthermore, if $\forall n_t > \bar{n}$, we have $u' > 0$ $u'' < 0$. We can define $f(m_t)$ as $\forall n_t > \bar{n}$ $f(m_t) = f(n_t - \bar{n}) = u(n_t)$. Hence, $f'(\bullet) > 0$, $f''(\bullet) < 0$, $f(\infty) = 1$, $f(0) = 0$, and $f'(0) > 0$. Substituting (21) in (8), we obtain, again, $\pi u'(n_t^*) = R$. Now, we need to check whether the local optimal value is globally optimal. For the case of $\pi u(n_t^*) - Rn_t^* > 0$, we have a positive solution $n_t^*$ satisfied FOC (figure 2); for $\pi\mu(n_t^*) - Rn_t^* = 0$, we have two solutions: one is 0 and the other is positive; for $\pi\mu(n_t^*) - Rn_t^* < 0$, we have a corner solution, which is 0. Hence, the globally optimal solution $n_t^E$ is given by

$$n_t^E = \begin{cases} 0 & if \ \pi\mu(n_t^*) - Rn_t^* \le 0 \\ n_t^* > 0 & if \ \pi\mu(n_t^*) - Rn_t^* \ge 0 \end{cases}, \tag{22}$$

**Participation assumption:** When there exists a $\bar{R}(\bar{n}, \chi, \alpha)$, $\forall R \in (0, \bar{R})$ individuals are willing to invest in R&D. Hereafter, we assume that this assumption holds.

[20] The trade-off between imitation and innovation is well discussed in Acemoglu et al. (2006).

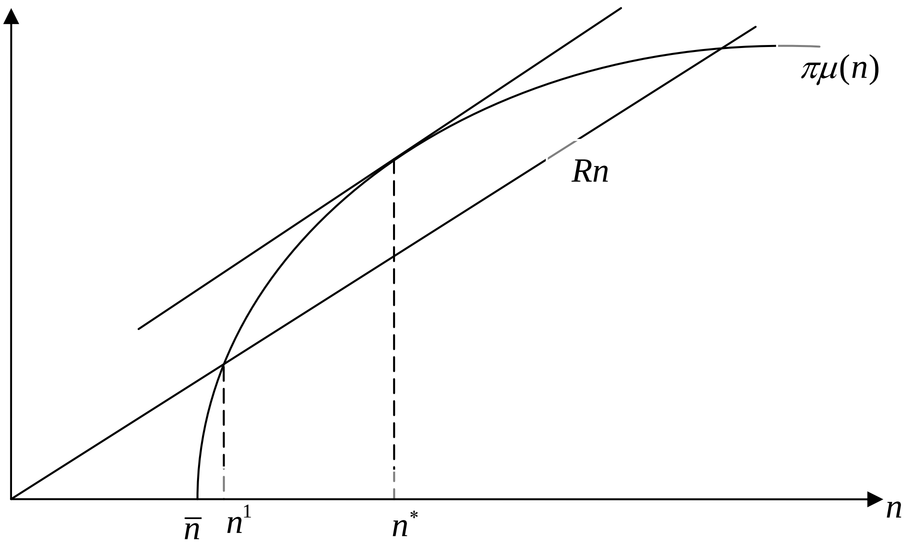


**Figure 2**

Now, we can distinguish three cases. Case 1: For very low $a_t$, $\omega(c)a_t < n^1$, and the optimal R&D investment is zero. Case 2: For $n^1 \le \omega(c)a_t < n^*$, the optimal R&D investment has a constraint $\omega(c)a_t$, where $n^1$: $Rn^1 = u(n^1)\pi \Leftrightarrow u^1 \equiv u(n^1) = Rn^1/\pi$ and $n^*$: $Rn^* = u'(n^*)\pi \Leftrightarrow u^* \equiv u(n^*)$. Case 3: For $\omega(c)a_t > n^*$, the R&D investment is the unconstraint optimal level $n^*$.

**Case 1:** $a_t < a^1 = \dfrac{n^1}{\omega(E+1)}$.

In this case, the government has no incentive to invest in the rule by law because individuals are not willing to invest in R&D. Hence, the government uses all efforts for industrial policies. If the population share of PPEs is $\bar{\lambda}$, the evolution equation of the technology gap is

$$a_{t+1} = \bar{\lambda}u^* + \frac{1-\bar{\lambda}u^*}{1+g}a_t. \tag{23}$$

Further, the steady state is

$$a^{1*} = \frac{\bar{\lambda}u^*(1+g)}{\bar{\lambda}u^* + g}. \tag{24}$$

The technology gap decreases ($a_t$ increases) according to the evolution equation (23). Potentially, it will reach the steady state before it is sufficiently large to avoid the case in which $a_t \le a^1$, and then the economy remains in industrial policies. There is no transition to the rule by law. Moreover, the condition $\frac{\bar{\lambda}u^*(1+g)}{\bar{\lambda}u^*+g} \le a^1$ provides some interesting implications:

**Corollary 1:** *The likelihood of remaining in the industrial policies forever is larger if 1) the world technology frontier grows faster, 2) $n^1$ is larger, and 3) $\bar{\lambda}$ is smaller.*

**Proof:** See Appendix 3.

The world technology frontier can affect domestic institutions. If $g \to 0$, the steady state is $a^{1*} \to 1$. The intuition is rather evident. The lower the growth rate of the world technology frontier, the smaller the technology gap of enterprises that have failed in innovation. Hence, the economy will eventually catch up with the world technology frontier, even under industrial policies. Nevertheless, the cost of industrial policies becomes increasingly larger with economic growth. The government will eventually find that the rule by law is more cost-beneficial before backward economies catch up with the frontier. Then, it will definitely enter into the second phase, where a transition to the rule by law begins. If $g \to \infty$, for backward economies, the failure of innovation implies a larger technology gap in the subsequent period ($a_t/(1+g) \to 0$). Hence, a growth maximization government has a larger incentive to choose industrial policies in order to ensure that certain enterprises achieve a higher innovation rate ($u^*$). In this case, the steady state approaches $\bar{\lambda}u^*$. On the other hand, $a^1$ approaches infinity due to a very small endowment of $\omega \to 0$. Consequently, the economy remains governed by industrial policies forever.

Further, $n^1$ increases fixed costs; hence, it is more likely for the government to intervene in an industry with higher fixed costs by implementing industrial policies. We have often found that even in a market economy, there were still many PPEs and government interventions in certain capital intensive industries, such as Airbus in Europe and Die Bahn in German. The airplane industry in Europe was a backward one compared to the United States at that time. The high fixed costs prevented private enterprises from investing in this industry. A government intervention encouraged the establishment of the Airbus Co.

$\bar{\lambda}$ measures the capacity of the government to manage PPEs. A stronger government that can manage many PPEs is capable of inducing a higher growth rate in a partial protecting strategy, which, in turn, triggers a transition to the rule by law in more advanced stages of development. It must be noticed that $\bar{\lambda}$ should be interpreted as the maximum number of efficient PPEs; thus, the inefficiency of PPEs is not included in our simple model (see footnote 8). Hence, our results do not directly contradict the tragic experience in China in the 1960s, when the Chinese government attempted to increase the number of SOEs, even to include the entire agriculture sector. After all farmers became "workers" in state-owned farms, the output declined dramatically and this led to a serious famine. This case precisely reflects that the cost of partial protecting strategy becomes extremely large if the share of PPEs approaches one. Hence, the Chinese government was not able to manage so many PPEs, as its $\bar{\lambda}$ was exceeded. A successful story through partial protecting strategy within $\bar{\lambda}$ (here, the innovation rate of SOEs is optimal, $u^*$) cannot be duplicated by simply increasing the share of PPEs over $\bar{\lambda}$.

**Case 2:** $a^1 \le a_t \le \frac{n^*}{\omega(E+1)} = a^2$ **.**

The first inequality implies that the maximum R&D investment is able to exceed $n^1$ if the government invests all efforts in establishing the rule by law. However, the second inequality implies that such R&D investment is still lower than the optimal level, $n^*$. Consider the decision of the government, $b_t$, which measures institutional reform: we know that the government is not willing to invest $b_t > 0$ that is so small that $(b_t+1)\omega a_t < n^1$ because such investment brings nothing to the government. Hence, the government must compare the maximum innovation rate with $b_t > 0$ for $(b_t+1)\omega a_t \ge n^1$ and the corner solution $b_t = 0$. The optimization problem for $(b_t+1)\omega a_t \ge n^1$ is expressed in the following manner:

$$\begin{aligned} &\max_{\lambda_t} \left\{ \lambda_t \left( u^* \bar{A}_{t+1} + (1-u^*) A_t \right) + (1-\lambda_t) \left( \tilde{u}\bar{A}_{t+1} + (1-\tilde{u}) A_t \right) \right\} \\ &s.t.\ \tilde{u} = f\left( \left( E - d(\lambda_t) + 1 \right) \omega a_t - \bar{n} \right), \qquad and \quad 0 \le \lambda_t \le \tilde{\lambda}_t \end{aligned}, \qquad (25)$$

where $\tilde{\lambda}_t = d^{-1}(E - \frac{n^1}{\omega a_t} + 1)$. It is the largest number of PPEs when the government invests $\frac{n^1}{\omega a_t} - 1$ in establishing the rule by law so that non-PPEs can invest just $n^1$

in R&D. It is easy to show that $\frac{\partial \tilde{\lambda}_t}{\partial a_t} > 0$, which implies more PPEs associated with economic growth if the government keeps the innovation investment of non-PPEs at the minimal level, $n^1$. Solving the above optimization problem, we have following proposition:

**Proposition 2:** *Define* $\tilde{\lambda}_t = d^{-1}(E - \frac{n^1}{\omega a_t} + 1)$ *and* $\lambda^*(a_t)$ *as the unconstrained optimal choice for* $a_t \in [a^1, \ a^2]$. *We obtain the following results:*

*1. If* $u^1 < \frac{\bar{\lambda} - \tilde{\lambda}}{1 - \tilde{\lambda}} u^*$, *government chooses* $\bar{\lambda}$ *until* $a_t$ *exceeds the threshold value* $\tilde{a}$*; thereafter it determines* $\lambda^*(a_t)$. *See figure 1.*

*2. If* $u^1 \geq \frac{\bar{\lambda} - \tilde{\lambda}}{1 - \tilde{\lambda}} u^*$, *the number of PPEs first decreases from* $\bar{\lambda}$ *to* $\tilde{\lambda}(a^1)$, *which increases in the technology gap,* $a_t$. *When* $a_t$ *exceeds the threshold value,* $\tilde{a}$, *the government chooses* $\lambda^*(a_t)$, *which decreases in* $a_t$. *The reduction of PPEs continues until* $\lambda^*(a^2) = 0$. *See figure 3.*

*3. The higher the fixed cost,* $\bar{n}$, *the greater is the likelihood of the second case (figure 3). If* $\bar{n} \to 0$, *we revert to the basic model (Proposition 1).*

**Proof:** See Appendix 4.

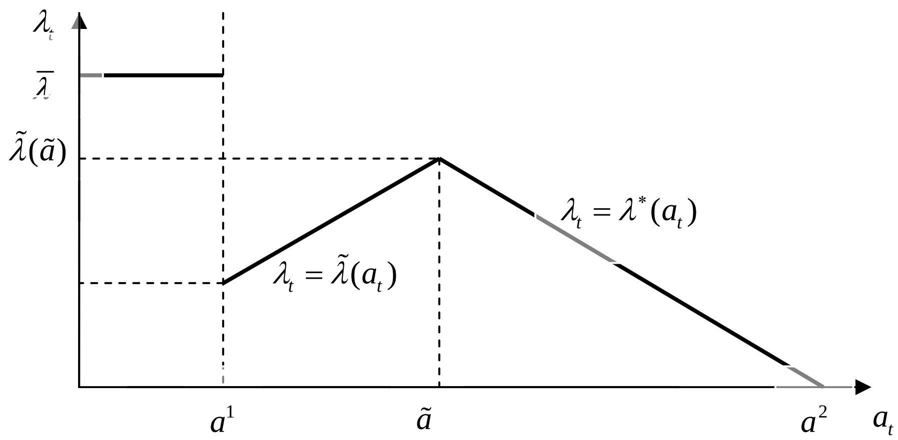


**Figure 3**

**Case 3:** $a_t > a^2$.

In this case, the economy enters into a period of the rule by law. The government invests all efforts in the rule by law, and there is no PPE. All non-PPEs invest at the unconstrained optimal level $n^*$. The economy grows according to (19).

In this section, with fixed costs, we reveal an interesting case where the transition to the rule by law could be zigzag in transition economies. If fixed costs are sufficiently large, figure 3 shows that the initial reduction of PPEs (from $\bar{\lambda}$ to $\tilde{\lambda}\left(a^1\right)$) is followed by an increase in the number of PPEs. The government induces private investment in R&D from zero to a minimal level $n^1$, which requires a reduction in the number of PPEs from $\bar{\lambda}$ to $\tilde{\lambda}\left(a^1\right)$. After this initial reform, the technology level is still low and individuals are still poor, thus, the government prefers to industrial policies. Hence, the effort for investing in the rule by law is maintained at the minimal level, which just induces non-PPEs' investments to be at $n^1$. With an increase in $a_t$, the government does not need to invest in the rule by law so much in order to maintain the level of private investment at $n^1$. Consequently, the number of PPEs increase (i.e., $\tilde{\lambda}\left(a_t\right)$ increases in $a_t$). Only if technology progresses further and exceeds $\tilde{a}$ will individuals become sufficiently rich that the government is willing to reduce the number of PPEs, as well as to improve the rule by law.

This theory could be used to explain the Chinese market-oriented reform, which shows a general market-oriented reform (decreasing SOEs) as well as a tendency called "SOEs forwards and privatization retreats" (*Guojin Mintui* in Chinese) in many industries[21]. As predicted in Proposition 2, this phenomenon is more likely if fixed costs are greater.

## 4. An PPE-biased government

The above discussion assumed a growth maximization government that aims to maximize the technology level for the entire society. It is possible that it establishes an institution *de facto* that is biased to PPEs (i.e., partial protecting strategy, or industrial policies); however, it is not biased *de jure*. Although we can interpret such a government as a dictatorial one whose interests have encompassed in the social welfare, someone could still challenge that the government in a gradualism reform is somewhat *de jure* biased toward PPEs. This is the important feature for gradualism. In a transition economy with a "Big Bang" strategy, all PPEs transformed to non-PPEs in a short period. Hence, the government has less incentive to be biased toward PPEs. However, for the government in a gradualism economy like China, the situation is

[21] There are many reports regarding such incidents; for example, Tieben Steel Co. in Jiangsu province was closed by the central government in 2004, and East Star Airline Co. in Hubei province was closed in 2009.

different. In such an economy, both PPEs and non-PPEs coexist for a long time. Hence, it is natural for the government to give more consideration to the technology of PPEs (as well as their profits) more than that of non-PPEs. Here, we model it by assuming a higher weight for PPEs in the objective function of the government.[22]

$$\begin{aligned}&\max_{\lambda_t} V_{t+1} = (1+\theta)\lambda_t\left(u^*\overline{A}_{t+1} + (1-u^*)A_t\right) + (1-\lambda_t)\left(\tilde{u}\overline{A}_{t+1} + (1-\tilde{u})A_t\right)\\ &s.t. \quad \tilde{u} = f\left((E-d(\lambda_t)+1)\omega a_t\right), \quad and \quad 0 \le \lambda_t \le \overline{\lambda}\end{aligned} \quad . \tag{26}$$

Solving (26), we obtain

FOC: $$\frac{dV_{t+1}}{d\lambda_t} = u^*\left(\overline{A}_{t+1} - A_t\right) + \theta u^*\left(\overline{A}_{t+1} - A_t\right) + \theta A_t - \left(\tilde{u}_t - (1-\lambda_t)\frac{d\tilde{u}_t}{d\lambda_t}\right)\left(\overline{A}_{t+1} - A_t\right) = 0 \tag{27}$$

Compared to the basic model, the above FOC equation has two additional items. $\theta u^*\left(\overline{A}_{t+1} - A_t\right)$ represents the extra utility from the successfully innovated PPEs and $\theta A_t$ is that from the failed PPEs. These additional items change the behavior of the biased government. Rearranging (28), we obtain

$$\frac{dv_{t+1}}{d\lambda_t} = \frac{1+g-a_t}{1+g}\left\{\theta(1+u^*) + \theta\frac{a_t}{1+g-a_t} - G(\lambda_t, a_t)\right\}, \tag{28}$$

where $v_t = V_t / \overline{A}_t$. Defining $H(\lambda, a, \theta) \equiv \theta(1+u^*) + \theta\frac{a_t}{1+g-a_t} - G(\lambda_t, a_t)$, if $\theta \to 0$ then we revert to the basic model; if $\theta \to \infty$, then $H(\lambda, a, \theta) >> 0$; hence, we obtain the corner solution $\lambda^* = \overline{\lambda}$. The intuition is clear from this. If the government is too biased toward PPEs, it is not willing to implement transition to the rule by law. If the government is totally neutral, both PPEs and non-PPEs are equally important in its utility function. Then, the government chooses the optimal strategy in different stages of development entirely on the basis of the growth maximization consideration. Now, we turn to the interesting case where the government is a little biased toward PPEs—that is, $\theta$ takes a medium value.

**Proposition 3**: *Let* $\theta_1 \equiv G_a(\overline{\lambda}, 0)$, $\theta_2 \equiv \frac{G_a(\overline{\lambda},1)g^2}{1+g}$, *where* $\theta_1 > \theta_2$.

*1) If* $\frac{G(\overline{\lambda},1)}{G_a(\overline{\lambda},1)} < \frac{u^*}{G_a(\overline{\lambda},1)} + \frac{g(1+gu^*)}{1+g}$ *, then the government with a higher* $\theta$ *(*$\exists\hat{\theta} \in (0, \theta_2)$ $\forall\theta > \hat{\theta}$*) is willing to insist on "industrial policies" forever, i.e.,* $\lambda^* = \overline{\lambda}$ $\forall a_t$*; and the government with a lower* $\theta$ *(*$\theta \le \hat{\theta}$*) prefers to establish*

[22] In this section, we assume $\overline{n} = 0$ for the sake of simplicity.

*"the rule by law" when* $a_t$ *exceeds a certain threshold value.*

*2) If* $\frac{G(\bar{\lambda},1)}{G_a(\bar{\lambda},1)} \geq \frac{u*}{G_a(\bar{\lambda},1)} + \frac{g(1+gu*)}{1+g}$*, there exists a transitory transition to the rule by law between the above two extreme ones.* $\exists \tilde{\theta} \in [\theta_2, \theta_1]$ *for* $\theta > \tilde{\theta}$*, the government insists that* $\lambda^* = \bar{\lambda}$ *for any* $a_t$*; and for* $\theta < \theta_2$ *the government initiates a stable transition where the number of PPEs reduces steadily to zero with economic growth.* $\forall \theta \in [\theta_2, \tilde{\theta}]$*, the government implements "industrial policies" in the early stages of development,* $\lambda^* = \bar{\lambda}$ *(*$a_t$ *is small); thereafter, the government reduces the number of PPEs and begins to establish the rule by law (*$\lambda_t$ *reduces) when* $a_t$ *exceeds certain threshold values. However, when* $a_t$ *grows further, the government is willing to increase the number of PPEs again and eventually reverts to the original case where* $\lambda^* = \bar{\lambda}$*.*

**Proof:** See Appendix 5 and figure 4.

Proposition 3 distinguishes three possible cases of institutional reforms: 1) when the government insists on industrial policies and there is no reform; that is, $\lambda^* = \bar{\lambda} \quad \forall a_t$, which we call "the stable partial protecting strategy"; 2) the stable and irrevocable transition to the rule by law, where the government initially chooses $\lambda^* = \bar{\lambda}$ for a small $a_t$ and then switches to reducing $\lambda$ for a big $a_t$ (see figure 1); and 3) the transitory transition, where the government begins to reduce $\lambda$ and then reverts to $\lambda^* = \bar{\lambda}$ with economic growth.

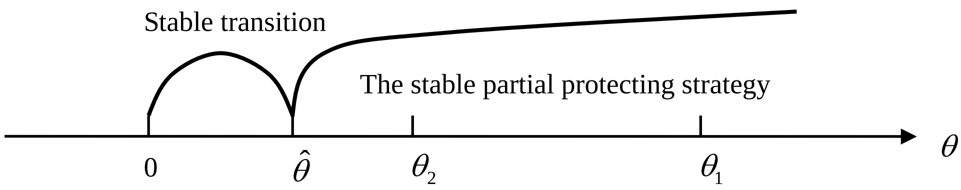


**Figure 4a The case of Proposition 3 (1)**

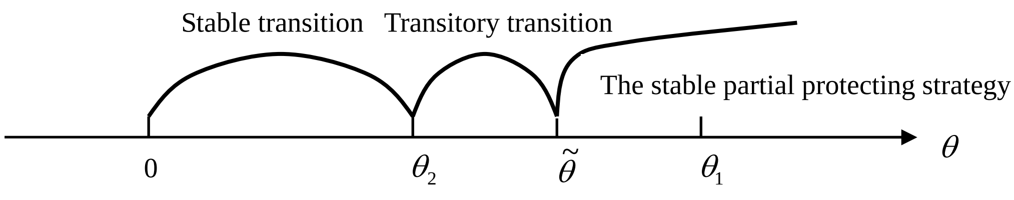

**Figure 4b The case of Proposition 3 (2)**

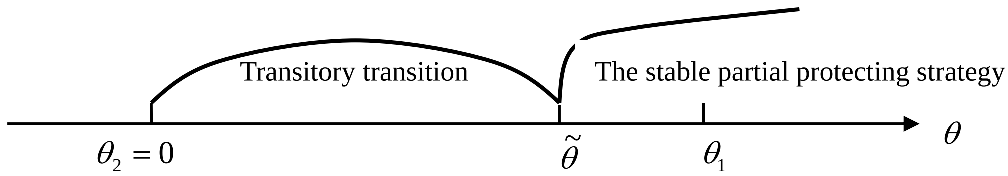


**Figure 4c The extreme case of Proposition 3 (2)** $g = 0$

Figure 4a presents the first result, which is very intuitive. It is of interest to see the second one (figure 4b) because it implies that the positive gradualism in China could be a transitory phenomenon. When an economy grows further, a *de jure* biased-to-PPEs government has great incentive to revert to industrial policies. In this sense, the "Big Bang" strategy is dominant because it eliminates the possibility of *de jure* biased-to-PPEs government. Further, our result implies that the possibility of this transitory gradualism stems from the cost of industrial policies. $G\left(\bar{\lambda},1\right)$ is the cost when there is no technology gap ($a=1$), and $G_a\left(\bar{\lambda},1\right)$ is its marginal cost; the condition that $\frac{G\left(\bar{\lambda},1\right)}{G_a\left(\bar{\lambda},1\right)}$ is sufficiently large implies that only a large cost of industrial policies is not enough to induce such transitory gradualism reform. Only if the cost of industrial policies is large relative to its marginal cost will such reform occur.[23]

The second interesting implication of this condition is the effect of the growth rate of the world technology frontier ($g$) on the possibility of this transitory transition. If $g \to 0$, the condition degenerates to $G\left(\bar{\lambda},1\right) \geq u*$ which holds for all $\theta$. Hence, we have only two possibilities: One is the stable partial protecting strategy, and the other is the transitory transition (see figure 4c). In other words, if g increases, $\theta_2$ also rises. Hence, the domain of the transitory transition decreases whereas the stable transition increases.

The faster the world frontier progresses, the larger the cost of industrial policies becomes. Hence, a backward economy with a *de jure* biased-to-PPEs government is more likely to initiate a stable transition to the rule by law. This theoretic prediction could be consistent with the experience of Chinese reform. China established a centrally planning economic system (it can be taken as the extreme case of industrial policies) from the beginning of the 1950s. It achieved a high growth rate at that time,

[23] It is a stricter condition than that $G\left(\bar{\lambda},1\right)$ is sufficiently large.

in particular in the 1950s and the beginning of the 60s. However, from the 60s to the 70s, the growth rate of other East Asian economies accelerated, and the Chinese growth rate declined.

These East Asian Tigers could be interpreted as frontiers for China because in our model, the frontier is the level that a backward economy can attain through innovation investment in one period. For China, the economic performance of the East Asian Tigers is more important than that of the United States or Japan in this sense. Facing the economic success of the East Asian Tigers, China initiated market-oriented reform in the 1980s. However, for the former Soviet Union, the United States was likely the frontier. Hence, the accelerated progress of the East Asian Tigers had less effect on the reform of the former Soviet Union, whereas good economic performance in the United States and technological progress in the weapon competition of the "cold war" pushed the former Soviet Union onto the track of reform in the 1990s.

Of course, this interpretation does not confirm that Chinese gradualism reform is stable and irrevocable. As we indicated earlier, gradualism reform could strengthen a *de jure* biased-to-PPEs government, which will possibly induce a transitory reform. However, we treat the measurement of bias exogenously, which simplifies the analysis. This could be unsatisfactory because the number of PPEs changes along with gradualism reform. We leave this aspect as a possible subject for future research.

## 5 Concluding remarks

This paper addressed an important question: "Why were some inefficient institutions, such as those industrial policies, or a centrally planned economy, established in the early stages of development and then abandoned in more advanced stages?" Our model treats this as the process of switching from industrial policies to the rule by law. The government of a backward economy wants to maximize the growth rate with two institutional tools: either to protect certain individuals in order to promote their investments or to improve the rule by law in order to induce R&D investments for all. In the early stages of development, the rule by law benefits less because individuals are poor. However, under industrial policies, resources can be collected for a few persons. Hence, its effect on the growth rate is relatively large. A centrally planned economy can be interpreted as the extreme case of industrial policies.

With economic growth, the cost of industrial policies becomes larger and the benefit of the rule by law increases as well. Hence, it is reasonable for a backward economy to implement a transition to the rule by law in more advanced stages of development. We modeled this as a reducing number of PPEs and increasing default cost under imperfect financial markets. This reform could be zigzag when we introduce a fixed cost in the R&D investment. There are also many cases in Chinese reform that confirm this prediction.

The other important extension is to allow a *de jure* biased-to-PPEs government, which is the important feature of gradualism reform. We distinguished two possible reform tracks: one is stable and irrevocable and the other is transitory. If the cost of industrial policies (which can be interpreted as the distortion of a centrally planned economy) is sufficiently large, then a transitory reform is possible even for a very biased government. The world technology frontier can affect the reform process in a backward economy. The acceleration in the growth of the world technology frontier increases the possibility of an irrevocable reform and reduces that of transitory reform. This conclusion supplies a reasonable interpretation for the reform processes in China and the former Soviet Union.

There are many aspects that can be delineated for further research. For example, we assumed a fixed effort for the government. In fact, it is endogenous if we interpret it as the tax revenue. Then, the total amount of available resources of the government depends on the strategy that it adopts. Further, we can also endogenize the bias measurement $\theta$ within a transition to the rule by law. It would be interesting to ascertain whether transition to the rule by law can be self-reinforced. We can also allow income heterogeneity across agents and human capital accumulation, which might show different and interesting results.

## Appendix

### Appendix 1

Using Assumption 1 we can prove $G_a(\lambda_t, a_t) > 0$

$$G_a = \omega\left\{ f'(\cdot)\left(E - d(\lambda_t) + 1\right) + (1-\lambda_t)\left(E - d(\lambda_t)+1\right) f''(\cdot)\omega a_t d'(\lambda_t) + (1-\lambda_t) f'(\cdot) d'(\lambda_t)\right\}$$

$$\frac{G_a}{\omega f'(\cdot)} = \left(E - d(\lambda_t)+1\right) + (1-\lambda_t)d'(\lambda_t) + (1-\lambda_t)\left(E-d(\lambda_t)+1\right)\omega a_t d'(\lambda_t)\frac{f''(\cdot)}{f'(\cdot)}$$

$$> \left(E - d(\lambda_t)+1\right) + (1-\lambda_t)d'(\lambda_t) - (1-\lambda_t)\left(E-d(\lambda_t)+1\right) a_t d'(\lambda_t)\frac{1}{(E+1)}$$

$$= \left(E - d(\lambda_t)+1\right) + (1-\lambda_t)d'(\lambda_t)\left[1 - \frac{E-d(\lambda_t)+1}{E+1}a_t\right] > 0$$

Using Assumption 2 we can prove $G_\lambda(\lambda_t, a_t) > 0$

$$G_\lambda = \omega a\left[(1-\lambda)d''(\lambda) f'(\cdot) - 2d'(\lambda) f'(\cdot) - (1-\lambda)\left[d'(\lambda)\right]^2 f''(\cdot)\omega a\right]$$

$$-\frac{G_\lambda}{\omega a_t} = 2d'(\lambda_t) f'(\cdot) + (1-\lambda_t)\left[d'(\lambda_t)\right]^2 f''(\cdot)\omega a_t - (1-\lambda_t)d''(\lambda_t) f'(\cdot)$$

$$< 2d'(\lambda_t) f'(\cdot) - (1-\lambda_t)d''(\lambda_t) f'(\cdot)$$

$$< 2d'(\lambda_t) f'(\cdot) - (1-\lambda_t)\frac{2}{1-\overline{\lambda}}d'(\lambda) f'(\cdot)$$

$$= 2d'(\lambda_t) f'(\cdot)\left\{1 - \frac{1-\lambda_t}{1-\overline{\lambda}}\right\} < 0$$

### Appendix 2

Solving FOC (16), we obtain $G\left(\lambda^*(a_t), a_t\right) = u^*$. Hence, the optimal choice $\lambda^*\left(a_t\right)$

is the function of $a_t$. Consider the case $\lambda_t = 0$ at first. Because $d'(0)=0$ we have:

$$G(0,a_t) = f\left((E+1)\omega a_t\right) + \omega d'(0) f'\left((E+1)\omega a_t\right) a_t = f\left((E+1)\omega a_t\right)$$

Hence, $G(0,a^2) = f\left((E+1)\omega a^2\right) = u^*$. From lemma 1 we know $G_a > 0$, hence, for $a_t < a^2$, $G(0,a_t) < u^*$. $\left.\frac{da_{t+1}}{d\lambda_t}\right|_{\lambda=0} = \left[u^* - G\left(0,a_t\right)\right] \geq 0$. Only when $a_t = a^2$, the ruler chooses $\lambda_t = 0$.

Now turn to the case $\lambda_t = \bar{\lambda}$. $G\left(\bar{\lambda},a_t\right) = (1-\bar{\lambda}) d'(\bar{\lambda}) f'\left((E+1)\omega a_t\right)\omega a_t$. Hence, $G\left(\bar{\lambda},0\right) = 0 < u^*$. From $G_\lambda > 0$ and $G(0,a^2) = u^*$ we know $G\left(\bar{\lambda},a^2\right) > u^*$. Therefore there exists a threshold value $\tilde{a} \in \left[0,a^2\right]$ so that $G(\bar{\lambda},\tilde{a}) = u^*$.

For $a_t \in \left(0,\tilde{a}\right]$, $G(\bar{\lambda},a_t) \leq u^*$, $\left.\frac{da_{t+1}}{d\lambda_t}\right|_{\lambda=\bar{\lambda}} = \left[u^* - G\left(\bar{\lambda},a_t\right)\right] \geq 0$. Hence, the ruler chooses $\lambda_t = \bar{\lambda}$;

For $a_t \in \left(\tilde{a},a_2\right]$, $G\left(\bar{\lambda},a_t\right) > u^*$, $\left.\frac{da_{t+1}}{d\lambda_t}\right|_{\lambda=\bar{\lambda}} = \left[u^* - G\left(\bar{\lambda},a_t\right)\right] < 0$. Together with $\left.\frac{da_{t+1}}{d\lambda_t}\right|_{\lambda=0} = \left[u^* - G\left(0,a_t\right)\right] \geq 0$ there is an interior solution $\lambda^*\left(a_t\right)$ so that:

$$G\left(\lambda^*(a_t),a_t\right) = u^*$$

It is easy to see that $\frac{d\lambda^*(a_t)}{da_t} = -\frac{G_a}{G_\lambda} < 0$ and $\lambda^*\left(\tilde{a}\right) = \bar{\lambda}$. See figure 1.

**Appendix 3**

We rearrange the condition $a^{1*} \leq a^1$ to get: $\frac{\bar{\lambda}u^*}{\bar{\lambda}u^* + g} \leq \frac{a^1}{1+g}$. According to the definition of $a^1$, we know that $\frac{a^1}{1+g} = \frac{n^1}{\omega(1+E)(1+g)} = \frac{n^1}{(1-\alpha)\zeta(1+E)}$, which is independent on $g$. Therefore, if $g \to 0$, then $\frac{\bar{\lambda}u^*}{\bar{\lambda}u^* + g} \to 1$. We know $1 > \frac{a^1}{1+g}$, hence, the economy will definitely enter into the next stage. If $g \to \infty$, then

$\frac{\bar{\lambda}u^*}{\bar{\lambda}u^*+g} \to 0$. The economy will definitely stay in the first case. The condition holds more easily for a larger value of $n^1$.

**Appendix 4**

In order to solve (23) we obtain

FOC: $$\frac{da_{t+1}}{d\lambda_t} = \left\{u^* - \tilde{u} - (1-\lambda_t) f'(\cdot) d'(\lambda_t)\omega a_t\right\}\left(1 - \frac{a_t}{1+g}\right) = 0$$

and SOC:

$$\frac{d^2}{d\lambda_t^2} = \left(1 - \frac{a_t}{1+g}\right)\omega a_t \left\{2d'(\lambda_t) f'(\cdot) + (1-\lambda_t)\left[d'(\lambda_t)\right]^2 f''(\cdot)\omega a_t - (1-\lambda_t) d''(\lambda_t) f'(\cdot)\right\} < 0$$

where $f(\cdot) = f\left(\left(E - d(\lambda_t) + 1\right)\omega a_t - \bar{n}\right)$.

Given assumption 2 $\frac{d''(\lambda)}{d'(\lambda)} > \frac{2}{1-\bar{\lambda}}$, SOC is satisfied.

We consider $\left.\frac{da_{t+1}}{d\lambda_t}\right|_{\lambda=\tilde{\lambda}}$ at first:

$G\left(\tilde{\lambda}(a_t), a_t\right) = f\left(n^1 - \bar{n}\right) + \omega a_t\left[1 - \tilde{\lambda}\left(a_t\right)\right] d'\left(\tilde{\lambda}\left(a_t\right)\right) f'\left(n^1 - \bar{n}\right)$ which increases in $a_t$. (because of $G_{\lambda_t}(\lambda_t, a_t) > 0$ and $\frac{\partial \tilde{\lambda}_t}{\partial a_t} > 0$ ) For $a_t = a^1$, $\tilde{\lambda}\left(a^1\right) = 0$ and then $G\left(0, a^1\right) = f\left(n^1 - \bar{n}\right) < u*$ hence $\left.\frac{da_{t+1}}{d\lambda_t}\right|_{\substack{\lambda=\tilde{\lambda} \\ a=a^1}} > 0$ ; for $a_t = a^2$ , $G\left(\tilde{\lambda}\left(a^2\right), a^2\right) > G\left(0, a^2\right) = u*$ hence $\left.\frac{da_{t+1}}{d\lambda_t}\right|_{\substack{\lambda=\tilde{\lambda} \\ a=a^2}} < 0$ . Therefore, there exists a threshold value $\tilde{a}$ so that $\left.\frac{da_{t+1}}{d\lambda_t}\right|_{\substack{\lambda=\tilde{\lambda} \\ a=\tilde{a}}} = 0$.

Then we consider $\left.\frac{da_{t+1}}{d\lambda_t}\right|_{\lambda=0}$ : Since $G_a(\lambda_t, a_t) > 0$ , we have $G\left(0, a_t\right) = f\left(\left(1+E\right)\omega a_t - \bar{n}\right) < G\left(0, a^2\right) = u*$, hence $\left.\frac{da_{t+1}}{d\lambda_t}\right|_{\lambda=0} > 0$. For $a_t \in \left[a^1, \tilde{a}\right]$, the solution of (22) is the corner solution $\tilde{\lambda}\left(a_t\right)$ , we show it in figure 6a; for

$a_t \in \left[\tilde{a}, a^2\right]$ we have an interior solution $\lambda^*\left(a_t\right)$, which is shown in figure 6b. Furthermore, it is easy to see that $\frac{d\lambda^*\left(a_t\right)}{da_t} = -\frac{G_a}{G_\lambda} < 0$ and $\tilde{\lambda}\left(\tilde{a}\right) = \lambda^*\left(\tilde{a}\right)$.

**For the case of figure 5a**， $a_t \in \left[a^1, \tilde{a}\right]$. We can distinguish two sub-cases:

Case 5a-1: $a_{t+1}\left(\tilde{\lambda}\left(\tilde{a}\right), \tilde{a}\right) \geq \bar{\lambda}u^* + \frac{1-\bar{\lambda}u^*}{1+g}\tilde{a}$. In this case, government reduces the number of PPEs from $\bar{\lambda}$ to $\tilde{\lambda}\left(a_t\right)$ at time t before $\tilde{a}$ reaches. Because $\tilde{\lambda}\left(a_t\right)$ increases in $a_t$, this reduction of PPEs is temporary, the number of PPEs $\tilde{\lambda}\left(a_t\right)$ arises with the growing technology.

Case 5a-2: $a_{t+1}\left(\tilde{\lambda}\left(\tilde{a}\right), \tilde{a}\right) < \bar{\lambda}u^* + \frac{1-\bar{\lambda}u^*}{1+g}\tilde{a}$. In this case, government doesn't reduce the number of PPEs.

Now we turn to simplify the condition $a_{t+1}\left(\tilde{\lambda}\left(\tilde{a}\right), \tilde{a}\right) \geq \bar{\lambda}u^* + \frac{1-\bar{\lambda}u^*}{1+g}\tilde{a}$

where $a_{t+1}\left(\tilde{\lambda}\left(\tilde{a}\right), \tilde{a}\right) = \tilde{\lambda}\left(\tilde{a}\right)\left[u* + (1-u*)\frac{\tilde{a}}{1+g}\right] + \left(1-\tilde{\lambda}\left(\tilde{a}\right)\right)\left[u^1 + \left(1-u^1\right)\frac{\tilde{a}}{1+g}\right]$

$$= \frac{\tilde{a}}{1+g} + \left[\tilde{\lambda}\left(\tilde{a}\right)u* + \left(1-\tilde{\lambda}\left(\tilde{a}\right)\right)u^1\right]\left(1-\frac{\tilde{a}}{1+g}\right)$$

Hence, the condition equivalents to $\tilde{\lambda}\left(\tilde{a}\right)u* + \left(1-\tilde{\lambda}\left(\tilde{a}\right)\right)u^1 \geq \bar{\lambda}u*$ which is, in turn, $u^1 \geq \frac{\bar{\lambda}-\tilde{\lambda}\left(\tilde{a}\right)}{1-\tilde{\lambda}\left(\tilde{a}\right)}u*$. When $\bar{n}$ arises, $u^1$ increases and $\frac{\bar{\lambda}-\tilde{\lambda}\left(\tilde{a}\right)}{1-\tilde{\lambda}\left(\tilde{a}\right)}$ decreases. Thus, the condition is more likely to satisfy. When $\bar{n} \to 0$, $a_{t+1}\left(\tilde{\lambda}\left(\tilde{a}\right), \tilde{a}\right) \to \bar{\lambda}u^* + \frac{1-\bar{\lambda}u^*}{1+g}\tilde{a}$. It is consistent with the basic model.

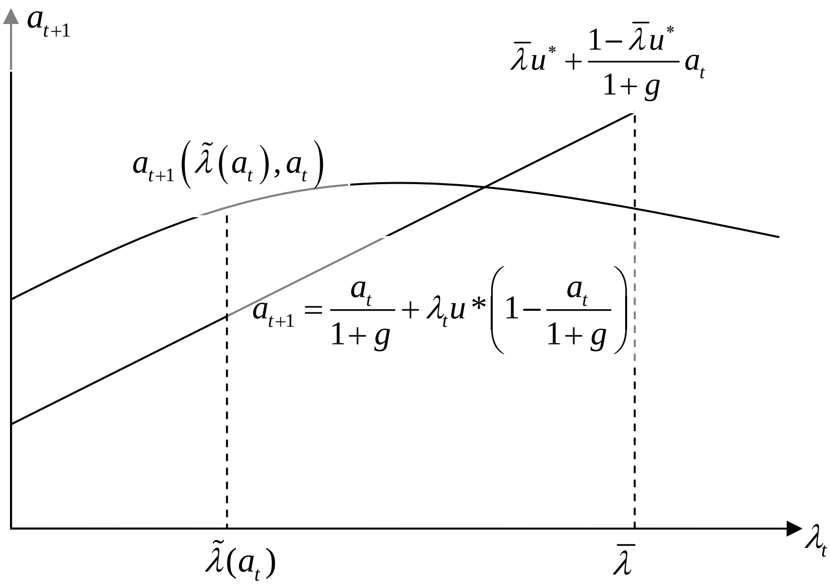


**Figure 5a**

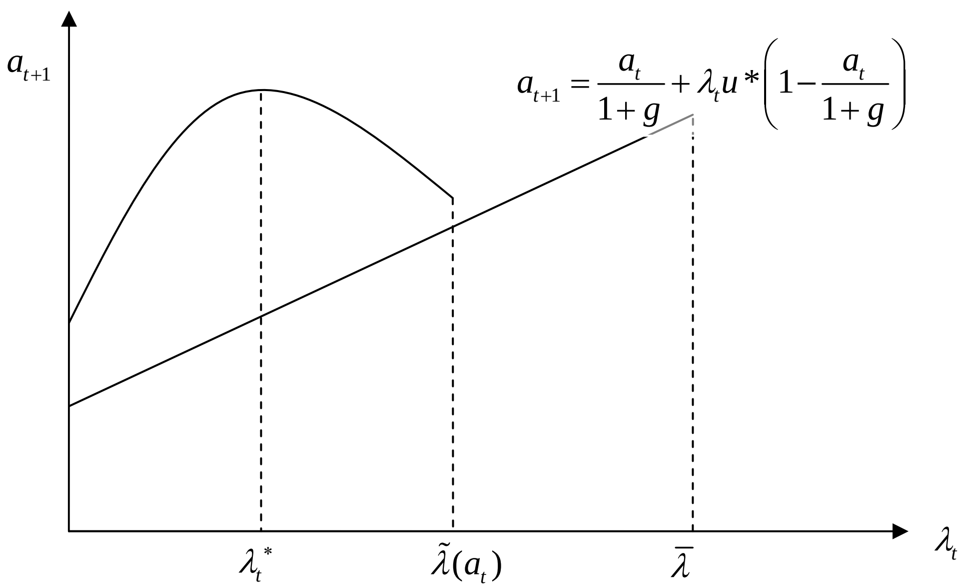


**Figure 5b**

**For the case of figure 5b，** $a_t \in \left[\tilde{a}, a^2\right]$.

Because $a_{t+1}\left(\lambda^*\left(a^2\right), a^2\right) = a_{t+1}\left(0, a^2\right) = u^* + \frac{1-u^*}{1+g}a^2 > \bar{\lambda}u^* + \frac{1-\bar{\lambda}u^*}{1+g}a^2$, there must exist a point of time $a_t \in \left[\tilde{a}, a^2\right]$, after that government reduces the number of PPEs from $\bar{\lambda}$ to $\lambda^*\left(a_t\right)$. Because $\lambda^*\left(a_t\right)$ decreases in $a_t$, the reduction of PPEs continues until $\lambda^*\left(a_t\right) = 0 \quad a_t = a^2$.

**Appendix 5**

$$H(\lambda,a,\theta)=(1+\theta)u^*+\theta\frac{a}{1+g-a}-G(\lambda,a)\ ,$$

we have $H_\theta>0$ and $H_\lambda<0$ because of $G_\lambda>0$.

**Case 1:** $\forall\theta>G_a(\bar{\lambda},0)\equiv\theta_1$ **we have** $\lambda^*=\bar{\lambda}$ **.**

Proof: At first $H_a(\bar{\lambda},0,\theta)=\theta-G_a(\bar{\lambda},0)>0$ in this case, then we have $H_{aa}(\bar{\lambda},a,\theta)=\frac{2\theta(1+g)}{(1+g-a)^3}-G_{aa}(\bar{\lambda},a)>0$ because of $G_{aa}<0$, hence, $\forall\theta>G_a(\bar{\lambda},0)$ we have $H_a(\bar{\lambda},a,\theta)>0$. Because we know already $H(\bar{\lambda},0,\theta)=\theta(1+u^*)>0$, together with $H_a(\bar{\lambda},a,\theta)>0$ we conclude $H(\bar{\lambda},a,\theta)>0$. Because of $H_\lambda<0$, $H(\lambda,a,\theta)>0$ $\forall\lambda$ Hence, we have the corner solution $\lambda^*=\bar{\lambda}$. Intuitively, if the government is too biased to PPEs ($\forall\theta>\theta_1$), it is not willing to set up the rule by law.

**Case 2:** $\forall\theta\in[\theta_2,\ \theta_1]$ *where* $\theta_2\equiv\frac{G_a(\bar{\lambda},1)g^2}{1+g}$ **, the government could choose a** $\lambda^*<\bar{\lambda}$ **if the minimal value of** $H(\lambda,a,\theta)$ **is negative, i.e.,** $G(\bar{\lambda},1)>(1+\theta_2)u*+\frac{\theta_2}{g}$ **; otherwise** $\lambda^*=\bar{\lambda}$.

Proof: in this case we have $H_a(\bar{\lambda},0,\theta)<0$ and $H_a(\bar{\lambda},1,\theta)>0$. Hence, there exists a $\hat{a}(\theta)\in(0,1)$ so that $H_a(\bar{\lambda},\hat{a}(\theta),\theta)=0$ because of $H_{aa}>0$. The $H(\bar{\lambda},\hat{a}(\theta),\theta)$ is the minimal value and $dH(\bar{\lambda},\hat{a}(\theta),\theta)/d\theta=H_\theta>0$ because of the envelop theorem. The maximal value of $H(\bar{\lambda},\hat{a}(\theta),\theta)$ is $H(\bar{\lambda},\hat{a}(\theta_1),\theta_1)$, which is positive; and the minimal value of $H(\bar{\lambda},\hat{a}(\theta),\theta)$ is $H(\bar{\lambda},\hat{a}(\theta_2),\theta_2)$.

**Case 2a: if** $H(\bar{\lambda},\hat{a}(\theta_2),\theta_2)$ **is positive**, then $H(\bar{\lambda},a,\theta)>0$ and in turn we have the same conclusion as the case 1: $\lambda^*=\bar{\lambda}$.

**Case 2b: if** $H\left(\bar{\lambda},\hat{a}\left(\theta_2\right),\theta_2\right)$ **is negative**, there must exist a $\tilde{\theta}\in\left[\theta_2,\theta_1\right]$ so that $H\left(\bar{\lambda},\hat{a}\left(\tilde{\theta}\right),\tilde{\theta}\right)=0$ and $H(\bar{\lambda},\hat{a}\left(\theta\right),\theta)<0 \quad \forall\theta<\tilde{\theta}$. Hence, there exists a stage of development $a_t\in\left[a^{**},a^*\right]$ when $H(\bar{\lambda},a,\theta)<0 \quad \forall\theta<\tilde{\theta}$. (see following figure) Furthermore, $H\left(0,a,\theta\right)>0 \quad \forall\theta$. The government choose an interior solution $\lambda^*<\bar{\lambda}$ in $a_t\in\left[a^{**},a^*\right]$. It is easy to know that $\frac{d\lambda^*}{d\theta}=-\frac{H_\theta}{H_\lambda}>0 \quad \frac{d\lambda^*}{da}=-\frac{H_a}{H_\lambda}$.

Hence, $\frac{d\lambda^*}{da}<0 \quad \forall a_t\in\left[a^{**},\hat{a}\right]$ and $\frac{d\lambda^*}{da}>0 \quad \forall a_t\in\left[\hat{a},a^*\right]$. Intuitively, if the government is a little biased to PPEs ($\forall\theta<\tilde{\theta}$), then it is willing to begin a market oriented reform when the technology level grows above the certain threshold value ($a_t\in\left[a^{**},a^*\right]$). However, the reform is transitory. After further growing and $a>a^*$, the government turns back to the "industrial policies" $\lambda^*=\bar{\lambda}$.

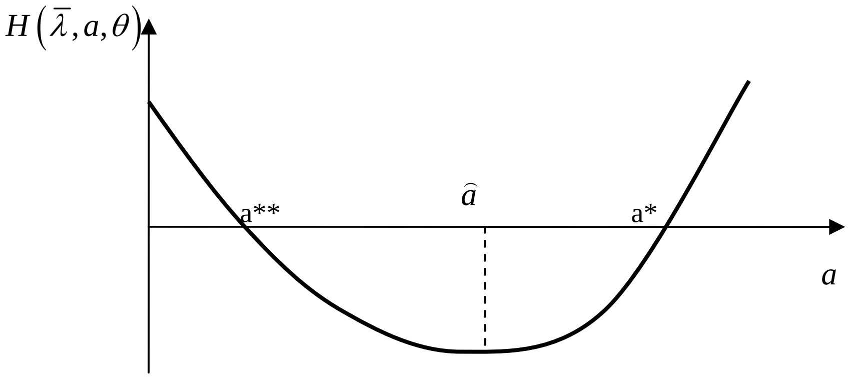


**Figure 6**

The condition $H\left(\bar{\lambda},\hat{a}\left(\theta_2\right),\theta_2\right)<0$ implies that $\left(1+\theta_2\right)u^*+\frac{\theta_2}{g}-G\left(\bar{\lambda},1\right)<0$ because $\hat{a}\left(\theta_2\right)=1$. Substitute $\theta_2\equiv\frac{G_a(\bar{\lambda},1)g^2}{1+g}$ into it we have $u^*-G\left(\bar{\lambda},1\right)+\frac{G_a(\bar{\lambda},1)g}{1+g}\left(1+gu^*\right)<0$. We divide $G_a\left(\bar{\lambda},1\right)$ on both sides to get

$$\frac{u^*}{G_a\left(\bar{\lambda},1\right)}+\frac{g\left(1+gu^*\right)}{1+g}<\frac{G\left(\bar{\lambda},1\right)}{G_a\left(\bar{\lambda},1\right)}.$$

**Case 3:** $\forall\theta\in\left[0,\theta_2\right]$ *where* $\theta_2\equiv\frac{G_a(\bar{\lambda},1)g^2}{1+g}$ **there must exist a** $\hat{\theta}$ **so that** $\forall\theta<\hat{\theta}$ **we have the same conclusion as Proposition 1.**

Proof: in this case, $H_a(\bar{\lambda},1,\theta)<0$ and the minimal value of $H(\bar{\lambda},a,\theta)$ is $H(\bar{\lambda},1,\theta)$ instead of $H(\bar{\lambda},\hat{a}\left(\theta\right),\theta)$. Because $H(\bar{\lambda},1,\theta)=\left(1+\theta\right)u^*+\frac{\theta}{g}-G\left(\bar{\lambda},1\right)$ increases in $\theta$, and $H(\bar{\lambda},1,0)=u^*-G\left(\bar{\lambda},1\right)=G\left(0,a^2\right)-G\left(\bar{\lambda},1\right)<0$, there must exist $\hat{\theta}$ so that $\forall\theta<\hat{\theta}$ $H(\bar{\lambda},1,\theta)<0$. In this case, the government chooses the "industrial policies" $\lambda^*=\bar{\lambda}$ if $a_t\in\left(0,\tilde{a}\right)$ and then begins market oriented reform $\lambda^*<\bar{\lambda}$ if $a_t\in\left(\tilde{a},1\right)$. It is same as Proposition 1.

Together with above two sub cases, we know that:

**Case 3a: if** $H\left(\bar{\lambda},\hat{a}\left(\theta_2\right),\theta_2\right)$ **is positive**, then $\hat{\theta}<\theta_2$

**Case 3b: if** $H\left(\bar{\lambda},\hat{a}\left(\theta_2\right),\theta_2\right)$ **is negative**, then $\hat{\theta}=\theta_2$.

Combining three cases together, we have proofed the proposition 3.

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