PRIVATE PROTECTION OF PROPERTY RIGHTS, INEQUALITY, AND ECONOMIC GROWTH IN TRANSITION ECONOMIES

Constantin Sonin[1]
Russian-European Center for Economic Policy and
New Economic School, Moscow

Abstract

For economies in transition, the issues of property rights protection provided by the state and implications for economic performance are very important. The paper develops an endogenous growth model with incomplete capital markets and the level of public protection of property rights determined by voting (possibly different from the majority voting). An exogenous in-flow to the economy that constitutes a rent-seeking pie reduces incentives to invest in production and negatively affects the growth rate. An empirical investigation verifies the implications of the model using cross-section data on Russian regions. During transition (since 1992), Russian regions demonstrated enormous differences in growth rates. It is found that these differences may be explained by initial conditions and effectiveness of institutions. Also, positive impact of inequality on the level of public protection of property rights is found and a theoretical explanation for this phenomenon in the framework of the model is provided.

[1]Russian European Center for Economic Policy, Potapovsky per. 5, bldg. 4, Moscow, 101000, Russia; e-mail: ksonin@nes.cemi.rssi.ru.

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1. Introduction

Recently, it has become very clear that liberalization, stabilization, and privatization in an economy in transition are not sufficient conditions for an upturn in economic activity. The Russian economy, as well as Ukrainian and some other transition economies, continues to stagnate. Among various explanations of the continued failure of these economies to grow, the inability of the state to promote development of 'good' economic institutions and the unexpected stability of 'bad' ones appears to be of particular interest.

Generally, the process of public enforcement and regulation of property rights by the state are influenced by social demands. Agents reveal their preferences over government policy through usual political mechanisms. It is quite natural to expect that it is the rich agents who favor the full protection of property rights. However, there is substantial evidence that in Russia, as well as in some other transition economies, the rich agents are the main beneficiaries of poor protection of property rights, which allows them to gain from non-productive activities such as rent-seeking through maintenance of appropriation capacities. (In this paper, rent-seeking is defined to be any costly redistributive activity.) In the absence of adequate public protection of property rights by the state, these rent-oriented structures took control of a substantial share of the national economy. More precisely, these structures (the largest of them are so called oligarchies) combine productive activity with an extensive struggle for the rent-seeking pie. Such rents have arose from various arbitrage opprotunities, provided, e.g., by foreign trade liberalization with incomplete price liberalization, or privatization in the absence of credit markets, which allowed managers to use state-subsidized credits on short-term money market (see Hellman, 1998). Their success at rent-seeking makes it non-surprising that the oligarchs prefer relatively poor protection of property rights. This in turn forces the other economic agents to invest in protection from appropriation. This may be the main reason why the Russian state has failed to

establish and enforce a clearly defined system of property rights as yet (see Leitzel, 1997). Recently, Frye and Shleifer (1997) conducted a survey of shopkeepers in Moscow and Warsaw and compared the effectiveness of the Russian and Polish legal systems in dispute resolution and the role of protection rackets. Their study showed that in Russia, the demand for private protection of property rights is extremely high, and also that enterprises have to operate in much more corrupt environment.

Private protection of property rights is defined to be the protection provided against other would-be protectors, contracting partners who fail or avoid to fulfill terms of the contract (e.g., repay the debt), usual criminals, etc. It is by no means assumed that an agent investing in private protection invests necessarily in military capacities or such like. Rather, it may be investment in relational capital, e.g. in establishing corrupt relations with state authorities, and even hiring a lawyer. In economic terms, it is a strategy of an economic agent to increase efficiency and predictability in its business relations. Hendley, Murrell, and Ryterman (1998) distinguish seven types of such strategies. However, their definition of private protection is too narrow for the approach employed in this paper. Private enforcement of property rights should also include such strategies as relational contracting (assumed to be costly) and corruption of state administration. Of course, the agent may simply pay for the third-party enforcement (mafia, say) [2]. Frye and Zhuravskaya (1998) provide the results of survey of shopkeepers in three Russian cities: 33 percent of respondents answered that enforcement of agreements is a function of racket.

In the initial Tullock (1980) model of rent-seeking and in a great majority of other papers devoted to directly unproductive activities, agents compare their costs with their benefits of participating in rent-seeking. In these models, agents usually have a clear choice of whether or not to participate in appropriation (or

[2]Leitzel (1997) stresses that the main difference between 'mafia' private protection and protection provided by a Western-style security firm is the difficulty of exit.

perhaps mix productive and appropriative activities). For Russia, it seems reasonable to assume that there can be no business without investment in private protection of property rights (Alexeev, Gaddy, Leitzel, 1997; Leitzel, 1997; Frye and Zhuravskaya, 1998). Then, as stressed in Shleifer (1995), the agents having private protection have incentives to appropriate resources from others. Thus, wide-spread private enforcement of property rights in transition economies is inherently stable.

There is substantial empirical and theoretical evidence that rent-seeking is harmful for growth. It is worth to emphasize three essential types of negative consequences of poor protection of property rights. First, the necessity to protect wastes resources as protection/appropriation is an unproductive activity. Second, the threat of appropriation distorts the economic environment and leads to suboptimal paths of capital accumulation and production. Third, extensive rent-seeking and improper public protection of property rights are usually associated with substantial income and wealth inequality. The impacts of inequality and redistribution policies on economic growth are studied in various growth theory papers. In Alesina and Rodrik (1994) and Persson and Tabellini (1994), it is shown, both theoretically and empirically, that inequality is harmful for growth. However, in these papers, and also in Perotti (1993), mechanisms of redistribution are designed in favor of the poor, while for Russia it seems more plausible to model redistribution of wealth in favor of the rich. Benabou (1996) extends these models (particularly, the model of Persson and Tabellini, 1994) to explore the impact of inequality on economic growth in detail. The theoretical model of the present paper lays in the general framework of Verdier (1994) and Bourguignon (1998) and follows the pattern of Benabou (1996).

Negative impact of poor protection of property rights on economic growth is stressed in classical works such as North (1981). Classical sources on rent-seeking are Krueger (1974) and Tullock (1980). Using axiomatic approach, income distribution in a rent-seeking environment is studied in Hirshleifer (1991), Skaperdas

(1992), and Skaperdas and Syropuolos (1997). In Grossman and Kim (1995), agents allocate real resources between appropriative and productive activities in a general equilibrium model. Although the game described in this paper is one-shot, in the concluding section authors state that it would be interesting to extend the model to a dynamic framework. In Murphy, Shleifer, and Vishny (1993), rent-seeking activity exhibit increasing returns and thus is more attractive relative to production. This leads to multiple equilibria, with "bad" equilibrium being stable and exhibiting a low level of output. It should be noted that for sufficiently high levels of rent-seeking, an increase in a number of rent-seekers reduces their income as the "pie" of the same size is divided by an increased number of participants. Also, there is a vast literature on interrelationship of law and finance (e.g., various papers of La Porta, Lopes-de-Silanes, Shleifer, and Vishny) which stresses the necessity of adequate investor and minority shareholder protection, etc.

Spontaneous emergence of property rights and appropriation activity in economies in transition were considered in Shleifer (1995) and in Polishchuk and Savvateev (1997). An empirical evidence on unofficial economy in transition (note that an unofficial economy relies exclusively on private contract enforcement) is presented and extensively discussed in Johnson, Kaufman, and Shleifer (1998). The political economy of partial reforms in transition economies with the emphasis on the role of powerfull rent-seekers is studied in Hellman (1998).

The rest of the paper is organized as follows. In section 2, a theoretical model is presented and its implications are briefly discussed. Section 3 presents results of an empirical investigation testing the theory implications, and discusses evidence obtained from other sources. Section 4 concludes.

2. The Theory

2.1. Agents

There is a continuum $[0,1]$ of heterogeneous overlapping-generations families. Each member i born at the period t has the utility function

$$u_{it} = \ln c_{it} + \rho \ln d_{it},$$

where c_{it} is consumption when young, d_{it} is consumption when old, and ρ is the common discount factor. This agent i is born endowed with individual-specific basic level of skills w_{it}. To simplify the subsequent analysis, I will assume that the skills are distributed across agents log-normally:

$$\ln w_{it} \sim N(m, \sigma^2),$$

and let w_t denote the mean (and the aggregate) level of basic skills, $w_t = Ew_{it} = e^{m+\frac{\sigma^2}{2}}$.[3] Intergenerational linkages are as follows:

$$w_{it+1} = \varepsilon_{it+1} y_{it}, \tag{2.1}$$

where ε_{it+1} is an i.i.d. shock with mean 1 and $Var\left[\ln \varepsilon_{it+1}\right] = \delta^2$, y_{it} is the second-period income of the member of family i (to be defined later). Similar assumptions are maintained in Persson and Tabellini (1994) and Benabou (1996). Herein time indices are skipped as the analysis is focused on members of one generation.

Each agent i has an access to a Cobb-Douglas technology, so that the second-period income is $y_i = A\widetilde{k}_i^{\beta} w^{1-\beta}$, where $\widetilde{k}_i$ is productive capital after redistribution, A is an exogenously given technological parameter, and w is the economy-wide endowment of basic skills. The $\widetilde{k}_i$ depends not only on the capital investment k_i of the agent i, but also on investment of the agent i into private protection of property rights and both types of investment of the other agents (see below). There are no credit markets, so agents have no possibility to borrow or lend to

[3] It is also assume that $\sigma^2 > \frac{\rho\beta}{1+\rho\beta}$.

optimize consumption intertemporarily. This idealistic assumption seems relevant in a study of economies in transition (see Polishchuk, 1995).

2.2. Private Enforcement of Property Rights

In addition to investment in production (see below), each agent may invest in protection of her property rights. If k_i is the capital expenditures of the agent i, and h_i is the amount invested in protection, then after redistribution the agent's i productive capital is $\widetilde{k}_i = k_i h_i^\theta g$. The factor g is defined by the balance condition

$$\int_0^1 \widetilde{k}_i di = \int_0^1 k_i h_i^\theta g di = \int_0^1 k_i di.$$

The parameter $\theta \geq 0$ measures the effectiveness of appropriative technology. (This technology is both offensive and defensive in the sense of Grossman and Kim, 1995.) The case $\theta = 0$ then corresponds to full public protection of property rights. In this case, $h_i = 0$, $g = 1$, and no redistribution actually take place. If $\theta > 0$, then, given the redistribution technology, each agent invests some positive amount of capital in appropriation/protection activity. Note that the balance condition above shows that the appropriative investment is totally wasted. In Tullock (1980) words, there is a negative sum game.

The after-redistribution capital of the agent i is

$$\widetilde{k}_i = \frac{k_i h_i^\theta}{\int_0^1 k_i h_i^\theta di} \int_0^1 k_i di.$$

This might be interpreted as a special form of Tullock rent-seeking competition (Tullock, 1980). Here contest inputs h_i are weighted by the amount of capital invested, and the whole capital invested in production forms the rent-seeking pie. This type of redistribution possesses the basic features of Tullock competition: the relative success is a function of the parties' respective resource commitments. Precisely, the agent's proportionate share of the pie depends positively on her contest input and negatively on contest inputs of the others. It should be noted that here the value of the prize, $\int_0^1 k_i di$, is endogenous variable as productive and

appropriative capital are rival uses of resources (see Hirshleifer, 1988 and Skaperdas, 1995). Also, it is assumed, departing from the initial Tullock framework, that each agent takes $\int_0^1 k_i h_i^\theta di$ as given.

2.3. Inequality and Growth

Agent i has the following maximization problem:

$$\max_{k_i,h_i} \left\{ \ln(w_i - k_i - h_i) + \rho \ln(A(k_i h_i^\theta g)^\beta w^{1-\beta}) \right\}.$$

This maximization problem presumes that there are no capital markets. Although such an extreme assumption is not unusual in transition literature, the case of perfect capital markets will be briefly discussed below (see Extensions). A standard procedure gives the solution:

$$k_i = \frac{\rho\beta}{1+\rho\beta(1+\theta)} w_i = p(\theta,\beta) w_i, \qquad h_i = \frac{\rho\beta\theta}{1+\rho\beta(1+\theta)} w_i = r(\theta,\beta) w_i.$$

The intuition is straightforward: investment in productive capital rises with improvement of property rights protection (θ decreases) and productivity, β; that is $p'(\theta) < 0$ and $p'(\beta) > 0$, while investment in appropriation and thus welfare losses rise with θ, i.e. $r'(\theta) > 0$. If property rights are fully secured, $\theta = 0$, then $h_i = 0$, and each agent splits his endowment between consumption and production.

Note that those agents that lose in redistribution overconsume in the first period, while those who gain underconsume compared to the case of $\theta = 0$. That is, beside the dead-weight losses, rent-seeking distorts economic environment. The second-period income of the agent i is

$$y_i = A s^\beta w_i^{(1+\theta)\beta} \frac{w}{\left(E w_i^{1+\theta}\right)^\beta}. \tag{2.2}$$

Summing over all agents, one can get an expression for the growth rate of the aggregate income:

$$\gamma(\theta) = \ln(y/w) = \ln A + \beta \ln s - \beta(1-\beta)(1+\theta)^2 \frac{\sigma^2}{2}. \tag{2.3}$$

The intuition is again straightforward. With low level of property rights protection (high θ) agents divert more resources from production to private protection of property rights (appropriation). This is in line with results of Murphy, Shleifer, and Vishny (1993).

Proposition 1. *Growth rate increases with the level of property rights protection by the state, and is maximized when property rights are fully secured,* $\theta = 0$.

The negative effect of poor protection of property rights comes from two sources: First, the higher is θ, i.e. the lower is the level of property rights protection by the state, the more resources, $\frac{\rho\beta\theta}{1+\rho\beta(1+\theta)}$, is devoted to private protection, a directly unproductive activity. Second, an increase in θ makes budget constraints more binding; this effect is reflected in the second term of equation (2.3): in the absence of asset markets poor underinvest compared to the socially efficient level. Since here the rich are the main beneficiaries of redistributive activity in the model, inequality (as represented by σ) hampers productive investment and thus growth given any level of property rights protection θ. If the capital market is perfect with the interest rate equal to the marginal product of productive capital, then the growth rate is $\gamma(\theta) = \ln A + \beta \ln s(\theta)$, and there is no second effect of incomplete protection of property rights as all the agents will invest the same amount of capital in production. Also, in this case inequality does not affect the growth rate. It is of course hard to imagine perfect capital markets in the absence of full protection of property rights. If we instead assume that loans and debts are subject for appropriation in the way described above, the results will be essentially the same.

In the current setting, the impact of inequality on growth is similar to those of Alesina and Rodrik (1994), and Benabou (1996) , and differs from those of Galor and Zeira (1993), Perotti (1993), Banerjee and Newman (1993), or Aghion and Bolton (1997), where effects of inequality and redistribution on growth depend on the initial wealth or income distribution. In Persson and Tabellini (1994),

the basic model yields similar results, but it is shown that the model may be easily modified to incorporate influence of initial wealth distribution on inequality effects. It should be noted that in all these models the poor are the beneficiaries of redistribution. Redistribution toward relatively poor agents may occur through progressive taxation of capital income, direct social transfers, extensive regulation, trade and capital restrictions, etc. (See Benabou, 1996 and Alesina and Rodrik, 1994.) Persson and Tabellini (1994) simply assume that incomplete protection of property rights (through proportional tax on income) leads to redistribution of wealth from rich agents to poor.

2.4. Political Economy

The next goal is to determine the level of property rights protection preferred by an agent i. Given some level θ, agent's i utility is:

$$u_i(\theta) = \ln(1-(1+\theta)s)w_i + \rho \ln As^{\beta} w_i^{(1+\theta)\beta} \frac{w}{\left(Ew_i^{1+\theta}\right)^{\beta}}.$$

Each agent faces the following maximization problem:

$$\max_{\theta \geq 0} u_i(\theta).$$

It is an easy exercise to prove that any agent i has single-peaked preferences over $\theta \geq 0$. This assures that the agent's i problem has a unique solution, θ_i^*.

Proposition 2. *Let* $\overline{w}$ *be such that* $\ln \overline{w} = 1 + m + \sigma^2$.

(i) Any agent i *with* $w_i \leq \overline{w}$ *prefers full protection of property rights,* $\theta_i^* = 0$.

(ii) Any agent i *with* $w_i > \overline{w}$ *prefers incomplete protection of property rights,* $\theta_i^* > 0$.

(iii) If $w_i \geq w_j$, *then* $\theta_i^* \geq \theta_j^*$; *that is, the richer the agent, the less secured property rights she prefers.*

In recent rent-seeking literature, the level of property rights protection is often endogenous (see, e.g., Grossman and Kim, 1995). However, the nature of

rent-seeking models left little chances that these models may be modified for the study of growth issues. Perotti (1993), Alesina and Rodrik (1994), Persson and Tabellini (1994), and Benabou (1996) have endogenized tax policy in the political equilibrium of endogenous-growth models. In this subsection, my main goal is to endogenize the level of property rights protection, as parametrized by θ, in an analogous way. I will assume that the old generation does not participate in the process.

The most straightforward approach is the use of the median-voter theorem of Grandmont (1978). However, it is doubtful that transition economies satisfy this "one person, one vote' ideal. Rather, anecdotal evidence suggests that in Russia and other FSU countries the level of property rights protection is determined by a relatively narrow group of powerful agents. Following Benabou (1996), let it be the pivotal voter located at the pth percentile of the wealth (instead of usual 50^{th} percentile). Then her wealth w_p is defined by $F((\ln w_p - m)/\sigma)) = p$, where F is the c.d.f. of a standard normal. One can reformulate this as follows: $\ln w_p = m + \lambda\sigma$, where $\lambda = F^{-1}(p)$. If $\lambda > 0$, that is $p > \frac{1}{2}$, the political system is biased toward rich. Historically, this case corresponds to wealth-restricted franchise, and today the bias toward rich might be due to their high lobbying power, imperfect political information, dependence on transfers from the central government in a transition economy, etc. For a deeper discussion of a wealth bias of political system, see Benabou (1996).

To investigate the effects of the wealth bias in the political system, substitute $\ln w_p = m + \lambda\sigma$ into $u_i'(\theta) = 0$ for $w_p \geq \overline{w}$ ($\lambda \geq \sigma + \frac{1}{\sigma}$) and note that $\theta^* = 0$ if $\lambda \leq \sigma + \frac{1}{\sigma}$:

Proposition 3. *(i) The more democratic is the society (the lower is the degree of wealth bias of the pivotal voter, λ), the more secure are property rights in the political equilibrium (the lower is θ^*). If $\lambda \geq \sigma + \frac{1}{\sigma}$, then θ^* strictly increases with λ.*

(ii) The political equilibrium leads to full public protection of property rights,

$\theta = 0$, *if and only if* $\lambda \leq \sigma + \frac{1}{\sigma}$.

(iii) An increase in inequality leads to a higher level of protection of property rights by the state.

The last statement follows from the fact that increased inequality reduces the appropriation gains of the rich, and thus makes incomplete protection less attractive. This effect complicates investigation of the impact of inequality on growth. While the direct effect of inequality on growth is negative, an increase in inequality forces the pivotal voter (who, all other things being equal, becomes poorer than before) to call for more secure property rights and favor more growth. Mathematically, one can write down $\frac{d\gamma}{d\sigma} = \frac{\partial \gamma}{\partial \sigma} + \frac{\partial \gamma}{\partial \theta}\big|_{\theta=\theta^*} \times \frac{\partial \theta^*}{\partial \sigma}$,where the first term on the right-hand side represents the direct effect of inequality on growth (holding policy, θ, fixed), and the second represents the indirect one. If property rights are fully protected, then inequality affects growth exclusively through binding wealth constraints.

2.5. Dynamics of Inequality and Multiple Equilibria

The formula 2.1 gives the intragenerational dynamics of income within a family. Combining with 2.2, this gives the law of motion for the family's income:

$$\ln w_{it+1} = \ln \varepsilon_{it+1} + \ln A + \beta \ln s + (1+\theta_t)\beta \ln w_i + \ln w - \beta(m(1+\theta_t) + (1+\theta_t)^2 \frac{\sigma_t^2}{2}),$$

where θ_t is the level of property rights protection chosen in period t. (Recall that θ_t is chosen by agents born at the period t.) Assuming $Var[\ln \varepsilon_{it+1}] = \delta^2$, one can get the autoregressive process for inequality:

$$\sigma_{t+1}^2 = \delta^2 + \beta^2(1+\theta_t)^2\sigma_t^2.$$

Now a marginal worsening of property rights protection increases not only the current inequality, but also inequality in all future periods.

Proposition 4. *If there is a strong wealth bias in the political system,* $\lambda \geq \sigma + \frac{1}{\sigma}$, *then there are multiple steady-states.*

The presence of multiple steady states may provide an explanation of considerably different transition paths of Poland and Russia (Frye and Shleifer, 1997). When a political system has a significant wealth bias, it may be locked in a bad long-run equilibrium, i.e. in an equilibrium with low level protection of public protection of property rights and low growth rate. As Hellman (1998) notes "the winners [of reforms] might have an implicit veto power in the decisions over separate components of reforms, especially those that affect their existing rent streams". Mathematically, a negative general equilibrium feedback of inequality on the level of property rights protection worsens budget constraints, and this effect allows to get multiple long-run steady states. The assumption of imperfect capital markets are crucial for this result: if agents are free to lend to and borrow from each other, their investment will always be socially optimal (given a level of property rights protection).

Many growth-theoretic models generate an inverted-U relationship between inequality and growth (e.g., Perotti (1993), Benabou (1996)). To allow for this effect in the model, it is necessary to introduce the 'inverse' redistribution from the rich to the poor (e.g., through progressive taxation and social security programs). Effects of such redistribution on growth in the case of full protection of property rights is studied in detail in Benabou (1996). In an economy with incomplete protection of property rights the redistribution toward poor will reduce direct effects of rent-seeking redistribution, but the qualitative results remain the same. Moreover, the situation will worsen as the rent-seeking pie will increase and the rich agents will have more incentives to invest in appropriation. This will also make existence of multiple bad equilibria even more probable.

The model above allows to get some implications about foreign direct investment in transition economies. Brock (1997) found foreign direct investment in Russia (and other FSU countries) to be much lower than in East European transition economies (not to say about developed countries). Similarly, FDI vary significantly across Russian regions. Our analysis sheds some light on this phe-

nomenon: first, investment in private protection is waste of resources for a foreign investor; second, in terms of the model above, the overall investment should be very large to allow for redistribution gains. The situation is even worse for a foreign investor as agencies providing protection in the host country can discriminate. Last but not least, such an investment may be considered illegal in the domestic country of the investor.

2.6. Why Is Manna so Harmful for Growth?

Murphy, Shleifer, and Vishny (1993) and Shleifer (1995) emphasize that rent-seeking may be self-generating. The situation is worse, the bigger is the rent-seeking pie. For example, when a foreign (e.g., IMF or the World Bank) loan is obtained, large rent-seekers may maintain their appropriative capacities to struggle for the pie, and then use the offensive weapons to appropriate resources from others. Offense creates the demand for defense, and so on. Also, the argument applies to many privatization cases. Further, where rent-seeking is allowed (public protection of property rights is poor), the natural rents (recall that the *Gazprom* pays 25 percent of taxes collected by Russian government) constitute an attractive pie.

Assume that, besides production and appropriation, an agent gains from rent-seeking, where the rent-seeking pie is exogenous. The agent's i share of the pie depends positively on her own investment in private protection (appropriation) , h_i, and negatively on investment of the other agents. Specifically, it is assumed that the agent's i productive capital after redistribution is $\widetilde{k}_i = k_i h_i^\theta g + \Delta w_i \frac{h_i^\theta}{H}$, where Δ is an exogenous rent-seeking pie, the multiplier g is defined as above by the balance condition on the capital market

$$g = \frac{\int_0^1 k_i di}{\int_0^1 k_i h_i^\theta di},$$

and $H = \int_0^1 h_i^\theta di$, the sum of contest inputs of all agents. (See Hirshleifer (1989) for properties of rent-seeking games of such type.) Again, the rent-seeking technology

favors rich: this is captured by the multiplier w_i. For the sake of simplicity, it is assumed that $\beta = 1$, and therefore inequality do not play any role in the subsequent analysis, and also $\rho = 1$. Thus, the agent's i problem can be written as follows.

$$\max_{k_i,h_i\geq 0, k_i+h_i\leq w_i} \left\{ \ln(w_i - k_i - h_i) + \ln(Ak_i h_i^{\theta} g + \Delta w_i \frac{h_i^{\theta}}{H}) \right\}.$$

Solving the problem, one can obtain optimal investment in production and appropriation in the presence of exogenous rent:

$$k_i = \frac{1}{2+\theta}\left(1 - \frac{\Delta(1+\theta)}{Ae^{\theta\sigma^2}}\right) w_i = p(\theta,\Delta)w_i, \qquad h_i = \frac{\theta}{2+\theta}(1+\frac{\Delta}{Ae^{\theta\sigma^2}})w_i = r(\theta,\Delta)w_i.$$

If the pie, Δ, is large enough, then the endowment, w_i, splits between consumption in the first period and investment in appropriation. In what follows, it is assumed that $\Delta \leq Ae^{\theta\sigma^2} \min\left\{\frac{1}{1+\theta}, \frac{2}{\theta}, 1+\theta\right\}$, and thus all solutions are interior. First, we observe that $p'_{\Delta}(\theta,\Delta) < 0$ and $r'_{\Delta}(\theta,\Delta) > 0$, i.e. the larger is the rent-seeking pie, the smaller is investment into production and the larger is the investment into private protection, which increase agent's proceeds from rent-seeking.

Proposition 5. *The larger is the rent-seeking pie, Δ, the lower is the growth rate $\gamma = \gamma(\theta,\Delta)$ of production in the economy.*

This result is very intuitive: the possibility to gain from appropriation of an exogenous pie reduces incentives to produce. If Δ is a one-time in-flow to the economy, the growth rate in production will be affected in the next period only. The result of Proposition 5 holds also in a more general setup (e.g., for $\beta, \rho \neq 1$).

3. Evidence

The theoretical model allows to formulate some empirical predictions: First, improper protection of property rights by the state and wide-spread rent-seeking has a significant negative impact on the economic growth of the economy. Second, an increase in income inequality may have positive impact on growth. It

should be assumed that the political system is wealth-biased (λ is positive and relatively large). Large rent-seeking pie should lead to a low level of property rights protection by the state.

3.1. Growth in Cross-Section of Russian Regions

In this subsection, the analysis is focused on Russian regional data. Since there are no reliable time-series data on many of our variables before 1994, the analysis is restricted to cross-section. I look at data from a cross section of Russian regions, each of which treated as a whole economy.

The following messages of the theoretical model should be verified:

— Improper public protection of property rights and wide-spread rent-seeking has a significant negative impact on the economic growth of a region. The hypothesis is that the larger the number of agents with relatively small endowments (such as small newly registered enterprises) and thus relatively small appropriation power, the higher the growth rate.

— Income inequality have positive impact on growth. Theoretically, it should be assumed that the political system is wealth-biased (λ is positive and relatively large).

— A priori, regional government's efforts to establish duly protected property rights and, more generally, to create a competitive environment should have positive impact on growth. Since increased control of regional administration over capital assets reduces the level of 'federal-level rent-seeking' in the region, it should lead to higher level of public protection.

— Large rent-seeking pie (as proxied by, e.g., the share of expenditures on governance in a region's budget) leads to a low level of property rights protection by the state.

It is usually a challenging task to find a good proxy for the level of rent-seeking (or the level of property rights protection). There are various indirect measures of rent-seeking based on government budgetary allocations. (Such a measure

may take into account pensions, social expenditures, tax privileges, etc.) For Russia, the "degree of expenditure centralization" and the level of region-specific taxation may serve as measures of rent-seeking activity. Capture of rents may be also reflected in data on regional-government control of its capital (buildings, equipment, machinery, etc.), including ownership claims to enterprise assets that are dispersed over several regions. For theft and racketeering (small-scale rent-seeking), the number of newly registered privately owned small enterprises might be used as a proxy of the level of public protection of property rights in a region. Laband and Sophocleus (1988), while measuring the social cost of rent-seeking using cross-sectional data on US states, employed the number of legal and business services establishments per capita in each state in a base year as proxies for the level of rent-seeking. Berkowitz and DeJong (1999) found that the formation of new enterprises has a significant positive impact on growth of Russian regions (see below). The model ultimately predicts the positive impact such enterprises have on the region's growth rate. It is likely that these new, small enterprises correspond to the agents in our model that have $\lambda \leq 0$ and so demand the optimal level of property rights protection.

In the empirical study, the risk ranking given to all Russian regions by the Bank of Austria using 1995 and earlier data was used as a proxy for the level of property rights protection. If property rights protection is defined as above, then there is a direct link between the protection and risk.

Different variables reflecting regional-government initiatives in the fields of privatization, price liberalization, and industry subsidization were employed. The idea is that the major source of differences in economic performance of Russian regions might be considerable difference of economic policies of regional governments, which have had substantial discretion over the implementation of reforms on the regional level. Berkowitz and DeJong (1999) found that regional-government privatization initiatives have had a significant positive impact on establishment of new legal enterprises, and thus promoted growth. In my empirical

exercise (see results and discussion below) I found no clear evidence in support of this view.

Since, as it is stated in Murphy, Shleifer, and Vishny (1993) 'public rent-seeking is likely to hurt innovative activities more than everyday production', it was *a priori* plausible to focus on regional private investment and consider it as a dependent variable. The theoretical model predicts that improper protection of property rights has a negative impact on investment. However, it was found that the entire set of our explanatory variables have a very limited explanatory power for our investment variable (using the average annual rate of change of investment in Russian regions in 1996-1997).

It is necessary to control for the influence of other possible determinants of growth of regions. The list of explanatory variables includes those reflecting industrial structure (e.g., the share of exportables or value-added of tradable-goods sectors in world prices at some base year), share of the military sector, and initial conditions (e.g., living costs in 1994). The first group accounts for regional economic differences resulting from the adjustment of different sectors to a partial opening of the Russian economy started in 1994. For military sector, we use the employment in the defense industry. This measure may also serve as a proxy for overall quality of labor force as employees of military sector are usually considered as more skilled than those employed in other sectors. Although the Russian government demand for military hardware declined sharply, it is shown in Gaddy (1996) that employment in the defense sector remained relatively stable during the transition.

The baseline models and estimation results are as follows. In both cases, I used similar specifications and report OLS results. Both pairs of regression were checked for potential simultaneity between Growth and NewEnt and Growth and Risk, respectively: the first estimations were 2SLS, the fitted values substituted into Growth regressions, and then the Hausman specification test (Green, 1997) was used to test the equivalence. The test statistics showed that there is no

evidence of simultaneity between Growth and NewEnt and Growth and Risk. This equivalence allowed to consider the OLS results only.

In doing this, data on 47 Russian regions in which the capital city comprises at least thirty percent of the total population (including Moscow and St.Petersburg) are employed. This restriction is due to two reasons: first, some data which are important for our investigation were collected at the capital-city level; second, anecdotal evidence suggests that such regions demonstrate tighter interconnection between policies and their outcomes. The control variables Defense, Moscow, Control, and North (i) are weakly correlated amongst themselves; (ii) have higher degree of correlation with NewEnt and Risk, than with Growth, and thus were used in the NewEnt and Risk regressions.

Data

The variables are defined as follows:

Growth	average annual growth rate of real per capita income, 1994-1997
NewEnt	number of legally registered small privately owned enterprises, 1996
Privat	index measuring the speed of regionally initiated small-scale privatization, 1996
Share	share of privatized small-scale enterprises, 1994
Control	index of regional-government control of its capital, 1995
Price	index measuring the extent of price liberalization, 1995
Govern	share of regional government's expenditures on governance, 1994
Subsidy	share of direct subsidies to enterprises in region's expenditures, 1995
Inequality	ratio of 5^{th} and 1^{th} quantiles, 1994
Initial	ratio of per capita money income to the cost of 19-bundle, 1993
IO	value-added of tradable-goods sector in 1985 per employed worker

Defense	number of workers employed in the military sector per thousand of employed workers, 1985
Municipal	the share of privatization initiated by the local government, 1994-95
Resources	an index of resource potential
Moscow	dummy for Moscow city
North	dummy for Northern territories (and territories with equal status)
PolitInst	index of political stability compiled by MFK Renaissance, 1995-96
Risk	risk rating compiled by the Bank of Austria, 1995-96

Sources: Goskomstat-RSY (1994-98): Growth, NewEnt, Inequality, Defense, Municipal, Share, Govern, Subsidy; TACIS (1995): Privat, Price, Control, Resources; Berkowitz and DeJong (1999): IO, Initial; MFK Renaissance: PolitInst; Bank of Austria: Risk.

Growth Regressions

The Growth regression is as follows:

Growth= $\beta_0 + \beta_1$Level-of-Protection+β_2IO+β_3Resources+β_4PolitInst+u.

There are two different proxies for the level of public protection: NewEnt and Risk. Correlation between the these two proxies is -0,82. Below the results of two OLS growth regressions are reported and briefly discussed. Sensitivity Analysis for the whole exercise is provided below.

Dependent variable: Growth

$R^2 = 0.439156$, $F(4, 42) = 8.2218[0.0001]$

Variable	**Coefficient**	**Std.Error**	**t-value**	**t-prob**
Constant	3.1777	4.4982	0.706	0.484
IO	0.1332	0.0458	2.906	0.006
PolitInst	-0.1730	0.0616	-2.811	0.008
Resources	-17.838	37.180	-0.480	0.634
NewEnt	1.4356	0.2796	5.136	0.000

Dependent variable: Growth

$R^2 = 0.556725$, $F(4, 42) = 13.187[0.0000]$

Variable	**Coefficient**	**Std.Error**	**t-value**	**t-prob**
Constant	26.9220	5.8023	4.812	0.000
IO	0.0817	0.0406	2.013	0.050
PolitInst	-0.1881	0.0545	-3.452	0.001
Resources	-30.499	33.270	-0.917	0.3645
Risk	-3.6359	0.5449	-6.672	0.000

The estimation results reported above are quite encouraging. Both the NewEnt and Risk variables (proxies for the level of public protection of property rights) are very (see *Sensitivity Analysis* below) significant (at 1 percent level) and has the predicted sign: the higher is the level of property rights protection by the state (lower the risk), the higher is the growth rate of real income per capita. The IO variable reflecting pre-transition industrial structure (higher IO means higher value-added of tradable-goods sector) and the index PolitInst for political instability (compiled by MFK Renaissance using 1995-96 data) are also significant at 1 percent level and have the expected signs. Political instability is bad for growth, while good initial position in terms of productive capacities leads to a higher growth rate (in the model the growth rate increases with A).

NewEnt and Risk Regressions

To test the model's predictions on impact of inequality and rent-seeking on the level of public protection of property rights, I estimated both proxies for the level of protection using variables for inequality (Inequality, ratio of 5^{th} and 1^{th} quantiles, 1994) and extent of rent-seeking (Govern).

NewEnt$= \delta_0 + \delta_1$Defense$+\delta_2$Moscow$+\delta_3$Control$+\delta_4$North$+\delta_5$Govern$+\delta_6$Inequality$+w$.

Risk $= \delta_0 + \delta_1$Defense$+\delta_2$Moscow$+\delta_3$Control$+\delta_4$North$+\delta_5$Govern$+\delta_6$Inequality$+w$.

Dependent variable: NewEnt

$R^2 = 0.681342,\ F(6, 40) = 14.254[0.0000]$

Variable	**Coefficient**	**Std.Error**	**t-value**	**t-prob**
Constant	0.7593	0.9199	0.825	0.414
Defense	3.4782	2.0213	1.721	0.093
Moscow	11.527	1.6800	6.861	0.000
Control	2.6300	1.2175	2.160	0.036
Inequality	0.1067	0.0293	3.636	0.000
North	1.9308	0.6223	3.103	0.003
Govern	-0.7702	0.2616	-2.944	0.005

Dependent variable: Risk

$R^2 = 0.499679,\ F(6, 40) = 6.6581[0.0001]$

Variable	**Coefficient**	**Std.Error**	**t-value**	**t-prob**
Constant	5.4490	0.5280	10.320	0.000
Defense	-2.0778	1.1602	-1.791	0.080
Moscow	-4.3077	0.96431	-4.467	0.000
Control	0.3075	0.6988	0.440	0.662
Inequality	-0.0420	0.15019	-2.499	0.016
North	-0.6341	0.357	-1.775	0.083
Govern	0.3663	0.1501	2.440	0.019

The results are again supportive for the theory. All the variables are significant at 10 percent level and have the expected signs. (Note that Risk and NewEnt have 'different signs': higher level of protection provided by the state is reflected by higher NewEnt and lower Risk. Thus, the coefficients in the two equations should have opposite signs.) Inequality is significant at 5 percent level in the NewEnt regression and at 1 percent level in the Risk regression. The coefficients show that an increase in the ratio of 5^{th} and 1^{th} quantiles improves public protection of property rights as it was predicted by the theory. One might infer that this finding provide some support for the assumption that the policy in Russian regions is determined by a relatively small group of rich agents (λ is large). The

rent-seeking proxy, Govern, is significant at 5 percent level in the NewEnt regression and at 1 percent level in the Risk regression. This also strongly supports the model's implications. The Moscow dummy is significant at 1 percent level in both regressions. However, it is more important that the inclusion of a dummy for Moscow have not altered the qualitative results. The Control variable is significant at 5 percent level in the NewEnt regression and is insignificant in the Risk regression (and has the wrong sign). The variable reflecting initial position in terms of human capital (Defense) has the predicted sign and is significant at 10 percent level in both regressions.

Why There Were No Policy Variables?

The list of variables above includes some variables reflecting differences in reform policies implemented at the regional level: privatization (Privat, Share, Municipal), price liberalization (Price), and subsidies for enterprises (subsidy). However, I found no possibility to obtain significant impact of any of these variables either on growth in 1994-97 or on level of property rights protection (basically, in specifications described above). One possible explanation is that these policy variables are endogenous to initial conditions (including inequality). It should be emphasized that Berkowitz and DeJong (1999) found a significant impact of reforms on growth of Russian regions. (The model specification was different.) For transition economies, there is a vast literature in support of the view that privatization and liberalization policies have very little effect on growth, while initial conditions and efficiency of institutions matter. (See, e.g., Popov, 1998).

To take into account possible influence of geographical positions, dummies for geographic territories, and a dummy for the regions taking control of more than 1 (5, alternatively) percent of known Russia's natural resources were employed. None of these dummies (with exception for the Moscow dummy and the dummy for Northern territories) were significant in either of regressions, and their use did

not alter the qualitative results of estimation. The statistical results obtained are robust with respect to modifications of the measures of growth and new enterprise formation. Specifically, the growth in per capita food purchasing power of money income (1993-1996) as an alternative measure of regions's growth (data on both measures were reported by Goskomstat) was used. For the development of new enterprises the total number of registered enterprises per thousand inhabitants were employed. These new regressions lead to results similar to those reported above; in particular, coefficients for NewEnt, IO, PolitInst in the growth regression and Inequality and Govern remained significant and having the expected sign. Also, we studied robustness excluding the insignificant variables from the analysis. The only change is that Defense becomes insignificant at 10% level.

To determine the validity of exclusion of Defense, Moscow, Control, Inequality, North, and Govern from the growth regression, I regressed Growth on the entire set of explanatory variables (separately for Risk and NewEnt) and then estimated the restricted equation by OLS. I obtained F statistic of 0.66 with P-value of 0.19. Then I conducted a usual exclusion-restriction test (see Greene, 1997) for each explanatory variable that does not enter the baseline growth regression. The smallest P-value obtained is 0.23. Also, there was found no evidence against exclusion of Growth from the NewEnt and Risk equations.

3.2. Other Evidence

The implications of the theoretical model are quite general and may be applied not only to economies in transition, but to development of poor countries and historical examples as well. For economies in transition, some recent papers provide support to the main general messages of the model: first, institutional environment is a key ingredient of economic recovery; second, political economy is very important. References include Johnson, Kaufman, and Shleifer (1998), Leitzel (1997), Popov (1998), Berglof and van Thadden (1999), and many others. Be-

low two papers which directly study Russian institutional environment are briefly discussed.

Recently, Frye and Shleifer (1997) conducted a survey of 105 small shops in Moscow (55) and Warsaw (50) to compare the effectiveness of the Russian and Polish legal systems in dispute resolution and the role of possible protection providers. Their study showed that in Russia, private protection of property rights is wide-spread, there is much more need in public protection, and also that enterprises have to operate in much more corrupt environment. Also, Frye and Zhuravskaya (1998) conducted a survey of shopkeepers in three cities in Russia and found that higher level of municipal-level regulation and lower levels of public good provision are associated with higher probability of work under private protection. All of these three cities (Moscow, Smolensk, Ulyanovsk) enter our data set (Growth=0.54, 0.04, -0.05, resp.) and are large cities located in the European part of Russia. For illustrative purposes, the reader is provided with some results of the survey (for the full detail, see Frye and Zhuravskaya, 1998):

	Moscow	**Smolensk**	**Ulyanovsk**
Number of permits required to open	6.23	5.29	8.77
Number of inspections [regulation]	16.34	16.22	21.96
Contact with racket ever, %	86.0	51.9	56.7
Rate your biggest problems, 1-10			
Taxes	8.57	8.00	8.38
Capital Shortage	6.57	6.67	6.97
Rental rates	7.88	5.58	6.02
Corruption	4.83	5.42	6.25

The results of this 'case study' are consistent with main messages of the empirical results of this paper: deregulation and proper public protection of property rights have positive impact on economic performance of a region. One surprising fact is that the survey shows that taxes are considered as the main problem by

a great majority of shopkeepers. Berkowitz and DeJong (1999), while explaining the insignificance of the tax variable in their growth regression, suggest that "much of the burden is in the form of unreported payments demanded by cash strapped or corrupt officials". However, it seems that the survey of Frye and Zhuravskaya (1998) have made an explicit distinction between the tax payments and the unreported payments for the respondents. So, it remains a puzzle.

4. Conclusion

Currently, the problem of effective enforcement and regulation of property rights is of crucial importance for Russia and other economies in transition. The results of the theoretical analysis and the existing empirical evidence clarify the mechanism underlying the negative influence of poor protection of property rights and the reverse effect of inequality on the economic performance of Russian regions. Agents with no political power to appropriate privately the fruits of their efforts must devote substantial resources to the protection of their productive capital, and this reduces the attractiveness of production. In other words, the contestability of property rights diminishes incentives to invest and accumulate capital. Income inequality, which has substantially increased during transition, has a significant and positive impact on the level of property rights protection. This suggests that the level of property rights protection is determined (in the framework of the analysis) by a narrow group of agents. In theory, it can be easily seen that improvements in the field of property rights protection (both in the level and the effectiveness), and a reduction in the level of rent-seeking activity, which in turn should reduce inequality, are unavoidable preconditions for economic growth. Such improvements may occur only if they are in the self-interest of the majority of population or at least of the majority of those who determine the policy. In this respect, further democratization should lead to more public protection of property rights, and thus increase growth.

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Appendix

Proof of Proposition 1.

The growth rate of the aggregate income is given by $\gamma(\theta) = \ln(y/w) = \ln A + \beta \ln s - \beta(1-\beta)(1+\theta)^2\frac{\sigma^2}{2}$.

If the level of property rights protection increases (i.e. θ becomes smaller), then $s(\theta) = \frac{\rho\beta}{1+\rho\beta(1+\theta)}$, the share of capital devoted to production, increases, and the term $\beta(1-\beta)(1+\theta)^2\frac{\sigma^2}{2}$ that represents losses due to redistribution and inefficient resource allocation, decreases. Thus, the growth rate $\gamma(\theta)$ decreases with θ. If $\theta = 0$, there is no redistribution, and the growth rate is maximized, $\gamma(0) = \ln A + \beta \ln \frac{\rho\beta}{1+\rho\beta} - \beta(1-\beta)\frac{\sigma^2}{2}$.

Inequality enters the last term of the growth rate expression only. If σ'^2 is larger, than the losses increase, since budget constraints (in the absence of complete financial markets) of agents become more binding. ■

Proof of Proposition 2.

First, we shall prove that the function

$$u_i(\theta) = \ln(1-(1+\theta)s)w_i + \rho \ln A s^{\beta} w_i^{(1+\theta)\beta} \frac{w}{\left(E w_i^{1+\theta}\right)^{\beta}}$$

is single-peaked for each i. For the maximization problem $\max_{\theta \geq 0} u_i(\theta)$, the first-order condition is $\frac{1+\rho\beta}{1+\rho\beta(1+\theta)} + \sigma^2(1+\theta) = \ln w_i - m$. Denote $\psi(\theta) = \frac{1+\rho\beta}{1+\rho\beta(1+\theta)} + \sigma^2(1+\theta)$, the left-hand side. Note that $\psi(0) = 1 + \sigma^2 > 0$. Taking the derivative, one gets $\psi'(\theta) = \sigma^2 - \frac{(1+\rho\beta)\rho\beta}{(1+\rho\beta(1+\theta))^2}$. Clearly, $\psi''(\theta) > 0$ when $\theta \geq 0$, and by assumption (see footnote 3 on page 5) $\psi'(0) = \sigma^2 - \frac{\rho\beta}{1+\rho\beta} > 0$. This implies that $\psi'(\theta) > 0$ for all $\theta \geq 0$, whence $\psi(\theta)$ is an increasing function of $\theta \geq 0$. Therefore, the first-order condition $\psi(\theta) = \ln w_i - m$ has at most one root $\overline{\theta} \geq 0$, and $u_i'(\theta) > 0$, if $0 \leq \theta < \overline{\theta}$ and $u_i'(\theta) < 0$, if $\overline{\theta} < \theta$. If there are no non-negative roots, i.e $\psi(0) \geq \ln w_i - m$, then $u_i'(\theta) < 0$ for all $\theta \geq 0$, and therefore, $\theta_i^* = 0$.

Now let $\overline{w}$ be such that $\ln \overline{w} = \ln w + 1 + \frac{\sigma^2}{2}$, where $w = Ew_i = e^{m+\frac{\sigma^2}{2}}$.

(i) If $w_i \leq \overline{w} = e^{1+m+\sigma^2}$, then $\psi(0) = 1 + \sigma^2 \geq \ln w_i - m$. Since $\psi'(\theta) > 0$ for all $\theta \geq 0$, $\theta_i^* = 0$ as shown in the Proof of Lemma 1.

(ii) If $w_i > \overline{w}$, then the equation $\psi(\theta) = \ln w_i - m$ has a positive root, θ_i^*.

(iii) The possibility to have $\theta_i^* = \theta_j^*$, when $w_i \neq w_j$ arises when $w_i \leq \overline{w}$ as shown in (i). To show that if $w_i > \overline{w}$, then θ_i^* strictly increases with w_i, suppose that $w_i < w_j$, and note that θ_i^* and θ_j^* are roots of equations $\psi(\theta) = \ln w_i - m$ and $\psi(\theta) = \ln w_j - m$, respectively. Then $\psi(\theta_i^*) < \psi(\theta_j^*)$, since ψ is strictly increasing in θ, and $\theta_i^* < \theta_j^*$ follows.■

Proof of Proposition 3.

The level of property rights protection by the state is determined by the pivotal agent p with w_p such that $\ln w_p = m + \lambda\sigma$. Thus, the equilibrium level of protection, $\theta^* = \theta_p^*$, satisfies $\psi(\theta^*) = \ln w_p - m = \lambda\sigma$.

(i) Since ψ is strictly increasing in θ, the lower is λ, the wealth bias, the lower is θ^*, the equilibrium level of protection. (Lower θ^* corresponds to more protection.)

(ii) Using (i) and Proposition 2.(i) and (iii), one gets that if $\lambda\sigma > 1 + \sigma^2$, then $\theta^* > 0$. On the other hand, if $\lambda\sigma \leq 1 + \sigma^2$, then $\theta^* = 0$. Therefore, an agent with $\lambda = \sigma + \frac{1}{\sigma}$ is the wealthiest agent voting for full public protection of property rights.

(iii) If $\theta^* = 0$, there is nothing to prove. Thus, it is assumed that $\theta^* > 0$. I analyze the first-order condition for the level-of-protection maximization problem, $\max_{\theta \geq 0} u_p(\theta) : \frac{1+\rho\beta}{1+\rho\beta(1+\theta^*)} = \lambda\sigma - \sigma^2(1+\theta^*)$. Note that the left-hand side does not depend on σ. If $\sigma^2 \geq \frac{1}{2}$, then the right-hand side shifts down and becomes steeper when σ increases. Thus, θ^* depends negatively on σ.

Now suppose that $\sigma^2 < \frac{1}{2}$, i.e. $\sigma < \frac{1}{4}$. Consider some $\sigma < \sigma'$, both less than $\frac{1}{4}$, and let $\theta^* = \theta^*(\sigma)$ and $\theta^{*\prime} = \theta^*(\sigma')$, respectively. First, we observe that if $\theta^* \geq \frac{\lambda}{\sigma+\sigma'} - 1$, then $\theta^{*\prime} < \theta^*$. Indeed, multiplying by $(\sigma'^2 - \sigma^2)$, one can rewrite the former inequality as $(\sigma'^2 - \sigma^2)\theta^* \geq \lambda(\sigma' - \sigma) - (\sigma'^2 - \sigma^2)$. Using $\frac{1+\rho\beta}{1+\rho\beta(1+\theta^*)} = \lambda\sigma - \sigma^2(1+\theta^*)$, one obtains $\frac{1+\rho\beta}{1+\rho\beta(1+\theta^*)} + \sigma'^2\theta^* \geq \lambda\sigma' - \sigma'^2(1+\theta^*)$. Therefore, the line $f(\theta) = \lambda\sigma' - \sigma'^2(1+\theta)$ lies below the line $f(\theta) = \frac{1+\rho\beta}{1+\rho\beta(1+\theta^*)} + \sigma'^2\theta^* - \sigma'^2\theta$ (note that both lines have the same slope). Since $\frac{1+\rho\beta}{1+\rho\beta(1+\theta)}$ decreases with θ, $\theta^{*\prime} < \theta^*$.

It remains to prove that $\theta^* = \theta^*(\sigma) \geq \frac{\lambda}{\sigma+\sigma'} - 1$. It is sufficient to show that

$\theta^* \geq \frac{\lambda}{2\sigma} - 1$. From the first-order condition, one gets $\lambda\sigma < 1 + \sigma^2(1+\theta^*)$. It follows that $1 + \theta^* > \frac{\lambda - 1}{\sigma}$. Since $\sigma < \frac{1}{2}$, $\lambda > 2\sigma(\lambda - \sigma)$. Hence, $\frac{\lambda}{\sigma} > \frac{\lambda}{2\sigma} + \lambda - \sigma > \frac{\lambda}{2\sigma} + \frac{1}{\sigma}$ (the latter inequality follows from $\lambda \geq \sigma + \frac{1}{\sigma}$). Therefore, we proved that $\theta^* \geq \frac{\lambda}{2\sigma} - 1$ as claimed. ■

Proof of Proposition 4.

There is a system of two equations that determines steady-states of the model:

$$\begin{cases} \sigma^2 = \delta^2 + \beta^2(1+\theta^*)^2\sigma^2, \\ \frac{1+\rho\beta}{1+\rho\beta(1+\theta^*)} = \lambda\sigma - \sigma^2(1+\theta^*). \end{cases}$$

Solving the first equation for $(1+\theta^*) = \frac{\sqrt{\sigma^2 - \delta^2}}{\beta\sigma}$, we substitute the result into the second equation to get $\frac{1+\rho\beta}{1+\frac{\rho}{\sigma}\sqrt{\sigma^2-\delta^2}} = \lambda\sigma - \frac{\sigma}{\beta}\sqrt{\sigma^2 - \delta^2}$,an equation in one variable. Rewrite it as follows: $\frac{1+\rho\beta}{1+\frac{\rho}{\sigma}\sqrt{\sigma^2-\delta^2}} + \frac{\sigma}{\beta}\sqrt{\sigma^2 - \delta^2} = \lambda\sigma$. It is straightforward to show that the left-hand side is an increasing concave function. Then there exists some $\overline{\lambda}$ such that for any $\lambda \geq \overline{\lambda}$, there are at least two steady-states.■

Proof of Proposition 5.

The first-order conditions are as follows: $\frac{1}{w_i - k_i - h_i} = \frac{A}{Ak_i + \Delta w_i/H}$ and $h_i = \theta(w_i - k_i - h_i)$. Then

$$k_i = \frac{1}{2+\theta}\left(1 - \frac{\Delta(1+\theta)}{Ae^{\theta\sigma^2}}\right)w_i = p(\theta,\Delta)w_i, \qquad h_i = \frac{\theta}{2+\theta}(1 + \frac{\Delta}{Ae^{\theta\sigma^2}})w_i = r(\theta,\Delta)w_i,$$

where the balance condition gives $gH = e^{\theta\sigma^2}$. Then the growth rate is given by

$$\gamma = \ln(y/w) = \ln A + \ln\frac{1}{2+\theta} + \ln\left(1 - \frac{\Delta(1+\theta)}{Ae^{\theta\sigma^2}}\right).$$

Clearly, the growth rate γ decreases with Δ, and γ is maximized when $\Delta = 0$.■