

economics Division Working Papers

Development Issues

*Can institutional transition stimulate
long-run growth?*

Yiping Huang

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- n.a. Not applicable
- .. Not available
- Zero
- . Insignificant

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abstract

This paper examines the growth and long-run implications of economic reform in transitional economies. An endogenous growth model is constructed in which investment in entrepreneurship is the engine of growth. Under central planning, individuals allocate all of their non-leisure time to current production. In equilibrium, the rate of output growth converges to the rate of population growth and per capita income stagnates. The introduction of free market institutions induces individuals to invest in entrepreneurial skills, facilitating rapid technological progress and higher levels of output and income growth.

For the former Soviet Union and in the late 1940s for most other countries—the new socialist economies were less developed than the old industrialized economies. The so-called “Soviet model” was a comprehensive system of economic policies instituted to achieve rapid growth. In essence, it contained three important elements: a development strategy oriented to heavy industry, central planning and public ownership (Huang and Danks 1995). Capital accumulation was seen as the source of economic development and was directly managed by the government. The adverse effects of central planning have become obvious over the past several decades. First, economic inefficiency was widely observed. Second, even though some economies achieved rapid growth in their early stages of central planning, such rates of growth could not be sustained. The rapid growth in the former Soviet Union in the pre- and immediate post-war years astonished the world. But its growth performance deteriorated over time and the economy experienced a collapse in the 1980s. Similarly, China achieved reasonably high rates of growth in the 1950s, but the economy collapsed around 1960 and did not achieve significant economic growth up to 1978.

Achievement of the first objective of economic reform—efficiency improvement—has been relatively observable/successful in many transitional economies, especially in China and Vietnam (Luo, Cai and Li 1994; Danks 1999). Realization of the second objective—achieving high and sustainable long-run growth after the transitional period—remains unmet. The only transitional economy that has maintained more

Can an institutional transition stimulate long-run growth?

The 1980s and the early 1990s have seen a worldwide drive to market-oriented economic reform in the (former) socialist economies. Economic reform in these transitional countries can be generalised as the transition from a centrally planned to a market economy. This transition has been strongly motivated by two objectives: more efficient resource use and income growth.

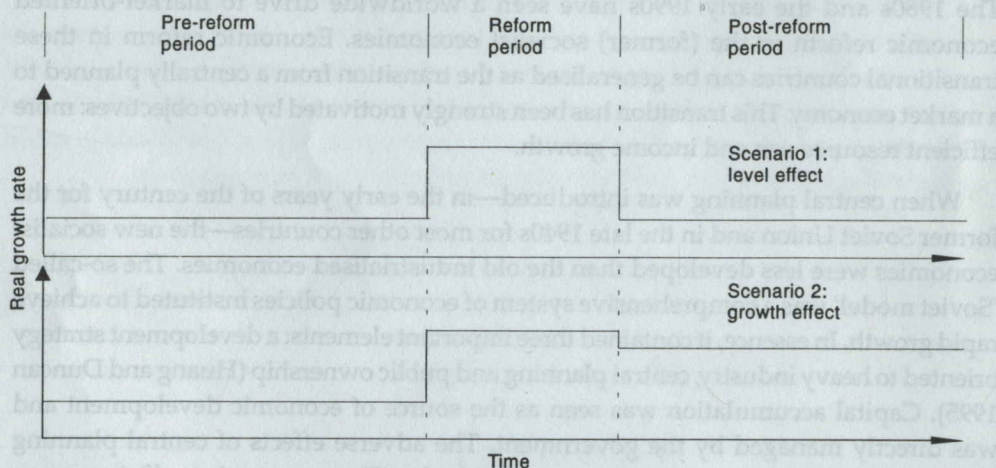
When central planning was introduced—in the early years of the century for the former Soviet Union and in the late 1940s for most other countries—the new socialist economies were less developed than the old industrialised economies. The so-called ‘Soviet model’ was a comprehensive system of economic policies instituted to achieve rapid growth. In essence, it contained three important elements: a development strategy oriented to heavy industry, central planning and public ownership (Huang and Duncan 1995). Capital accumulation was seen as the source of economic development and was directly managed by the government. The adverse effects of central planning have become obvious over the past several decades. First, economic inefficiency was widely observed. Second, even though some economies achieved rapid growth in their early stages of central planning, such rates of growth could not be sustained. The rapid growth in the former Soviet Union in the pre and immediate post-war years astonished the world. But its growth performance deteriorated over time and the economy experienced a collapse in the 1980s. Similarly, China achieved reasonably high rates of growth in the 1950s, but the economy collapsed around 1960 and did not achieve significant economic growth up to 1978.

Achievement of the first objective of economic reform—efficiency improvement—has been relatively observable/successful in many transitional economies, especially in China and Vietnam (Lin, Cai and Li 1994; Drabek 1990). Realisation of the second objective—achieving high and sustainable long-run growth after the transitional period—remains untested. The only transitional economy that has maintained more

than a decade of rapid output growth is China whose real growth has averaged over 9 per cent per annum since 1979. Even 16 years of high growth, however, does not provide a clear indication of the impact of economic reform on long-run growth.

This leads to an interesting theoretical question: does economic reform in transitional economies have a level effect or a growth effect on long-run growth? A level effect means that economic reform moves the economy to the technological frontier during the reform period, but that the long-run growth rate does not change (Scenario I, Figure 1). A growth effect, on the other hand, implies that economic reform not only improves the economy's efficiency in the short run but also stimulates its technological progress and long-run growth (Scenario II, Figure 1) (Solow 1956; Lucas 1988).

Figure 1 Level effect versus growth effect of economic reform



The standard neo-classical growth models have dominated thinking about economic growth (Solow 1956; Cass 1965). As technological progress is determined outside the system, these models do not shed light on the relationship between government policy and growth performance. The growing literature on the new growth theory introduces the idea of relationships between economic growth and endogenous technological progress and government policy. Although there is disagreement among theorists about the role of government policy in determining growth, policies do have impacts on long-run growth through their influence on individual consumption and investment decisions.

In this study, an endogenous growth model is constructed in which investment in entrepreneurship is the primary engine of growth. Entrepreneurship is given particular attention because of its crucial importance to economic growth in transitional

economies. The externalities of human capital or new knowledge/invention can only materialise when the firm has the capacity to comprehend and the ability to implement. A certain level of entrepreneurial skill is a necessary part of that ability.

The model examines the implications of two different economic institutions—central planning and free markets—for long-run growth. The distinction made between the two institutions is different from that used in the endogenous growth literature. The stylised central planning system is destined to portray the essence of the economic practices in the former socialist countries. Under free market institutions, on the other hand, it is assumed that all decisions are made by decentralised individuals.

Earlier literature

A large amount of literature has been produced on the impact of economic reform in the former socialist countries since institutional transition began in the late 1970s (Fischer 1993; Sachs and Woo 1994; Li, Cri and Li 1994). Most of these studies look at changes in policy regimes and examine the effects of these changes on output and income in the short term. Although productivity growth is a central concern, there is usually no distinction made between efficiency improvement and technological progress. Lin's (1988, 1990, 1992) work on China's agricultural reform shows how the transition from pre-reform production teams to the household responsibility system contributed to output and productivity growth. This has some similar features. The examination of the impact of reform on long-run growth is based on the analysis of changes in individual optimisation decisions, analogous to Lin's analysis of farmers' effort decisions.

This study differs from most of the literature on economic reform in that it concentrates on effects of the transition on the long-run growth pattern rather than on the transition itself. Allocative and technical inefficiencies are assumed away and therefore all production activities operate on the technological frontier, whether under central planning or free market.

The model constructed has the usual characteristics of endogenous growth and increasing returns following on the pattern of analysis. But it has some special features which differ from the other endogenous models (such as those by Romer [1986, 1990] and Lucas [1988]).

The first important difference concerns the role of economic institutions (or policy regimes) in the determination of growth. The development of the new growth theory is strongly motivated by drawing policy implications. The existing literature only looks at the impact of taxation or subsidy policies in different sectors (goods production sector or research and development sector). Romer (1990) for example, discusses the different roles of government taxes and subsidies in the context of his model. King

and Rebelo (1990) apply a calibrated, two-sector endogenous growth model and show that national taxation can substantially affect long-run growth rates. Barro (1990) extends the endogenous growth model assuming constant returns to a broad concept of capital that includes tax-financed government services affecting production and utility. In another study, Segerstrom (1991) develops a dynamic general equilibrium model of economic growth and suggests that innovation subsidies unambiguously promote economic growth. In general, the main subject of these studies is the choice of policy variable (taxes or subsidies). Little effort has been devoted to examining the growth implications of different institutional settings. The literature, therefore, has limited usefulness for the discussion of the changing growth pattern in transitional economies. In this study, two distinct economic institutions are analysed in an endogenous growth framework in a stylised manner and their influence on long-run growth investigated.

The second important difference relates to the definition of economic institutions. In the growth literature, the central planner is assumed to maximise the economy's aggregate (lifetime) welfare by choosing aggregate variables such as total capital stock and total consumption. Romer (1986) and Schmitz (1989) demonstrate that, in their endogenous growth models, equilibrium might be different when decisions are made by the central planner (social optimisation) and when decisions are made by decentralised individuals (equilibrium). In other cases, social optimisation and equilibrium might be identical (Caballé and Santos 1993).

In this study, the definition of central planning relates closely to the experience of the socialist countries. The planner organises all activities of production and consumption and always seeks to maximise investment in physical capital. Markets are abolished and prices are set by the state. The planner buys labour time from individuals and pays at fixed wage rates. The contribution of human capital, or entrepreneurship, is ignored partly because it is hard to measure without a market mechanism and partly because the government does not want to pay individuals more than 'necessary'.

The third difference lies in the treatment of entrepreneurship and the realisation of externalities in the model. Recent theories of endogenous growth have focused primarily on the direct production of knowledge and its role in the growth process (Romer 1990). Externalities materialise automatically as long as new knowledge is gained by new inventions taking place. While this simple treatment is useful in explaining why production activities exhibit increasing returns to scale over time and why an economy can grow at higher rates, it ignores the importance of imitation and implementation of knowledge in promoting growth. Increases in new knowledge are a necessary, but not a sufficient, condition for productivity growth. Baumol (1986, 1988) provides historical descriptions of economies in which important inventions were made but sustained growth did not follow. The economy of ancient China is

often presented as a classic example of an economy where very little effort was devoted to imitating and implementing new ideas. The history of the former Soviet Union provides another. In a recent study, Huang and Duncan (1995) examine the effects of economic reform on China's technological profile and discuss some implications for long-run growth. Drawing on the growth experience of the former Soviet Union and China, they speculate that the slowdown of economic growth in these economies during the period of central planning was associated with the dominance of the state and heavy industry in the economy and the lack of entrepreneurship (what they term 'management knowledge and marketing skill'). This implies that there is one all-important factor—entrepreneurship—necessary for converting knowledge or invention into productivity.

Entrepreneurship is recognised as a key factor in economic growth. There are several models that attempt to incorporate entrepreneurship in explaining development and growth experiences. Schumpeter (1934), for instance, distinguishes between innovating and imitating entrepreneurs. In his model the innovating entrepreneur plays the key role, with imitators assigned a minor part in the growth process. In a similar manner, Segerstrom (1991) develops a dynamic equilibrium model of economic growth incorporating innovation and imitation. Schmitz (1989) presents a model in which endogenous entrepreneurial activity is a key determinant of economic growth. Growth is driven by the imitative activities of entrepreneurs.

In this study, however, entrepreneurship is incorporated in a different way. It is the level of entrepreneurial skill (rather than entrepreneurial activity as modelled by Schmitz), which is a result of investment behaviour, that is deemed to affect firms' productivity. New knowledge can only contribute to productivity growth when the incentive structure encourages individuals to apply it. In this study the incentive structure is directly related to the institutional settings of the economy.

The basic model

The analysis begins with a standard growth model with an unbounded horizon. The basic structure is more in line with the free market regime. Modifications are required for discussion of equilibrium under central planning.

The economy has a large fixed number of firms, M , and each firm has a population of $N_i(t)$ at time t . Firms are indexed by $i \in [0,1]$ and the infinitely lived individuals for a representative firm are indexed by integral number $j(t) \in [1, N(t)]$. The population, and so the population of the representative firm, grows at a fixed rate of n per period.

All firms produce the same good, which can be used either for consumption or for investment in physical capital, using the same or different technologies. The production technology under both central planning and the free market is characterised by

$$Y(t) = F(A(t), K(t), L(t)) = A(t)f(K(t), L(t)) \quad (1)$$

where $A(t)$ is the total factor productivity shifter, at time t , $K(t)$ is physical capital stock and $L(t)$ is the total labour time input. The function $f(\dots)$ is concave, increasingly monotonic, and homogeneous of degree one in $K(t)$ and $L(t)$, which implies that

$$f_K(K(t), L(t)) > 0, \quad f_L(K(t), L(t)) > 0 \quad (2)$$

$$f_{KK}(K(t), L(t)) < 0, \quad f_{LL}(K(t), L(t)) < 0, \quad f_{KL}(K(t), L(t)) < 0 \quad (3)$$

$$f(\lambda K(t), \lambda L(t)) = \lambda f(K(t), L(t)) \quad (\text{where } \lambda > 0) \quad (4)$$

where the sub-index denotes the variable with respect to which the partial derivative is taken. Both capital stock and labour time are necessary in production. Given $\bar{K} > 0$ and $\bar{L} > 0$,

$$\lim_{L \rightarrow 0} f_L(\bar{K}, \bar{L}) = \lim_{K \rightarrow 0} f_K(\bar{K}, \bar{L}) = \infty \quad (5)$$

$$f(0, \bar{L}) = 0, \quad f(\bar{K}, 0) = 0 \quad (6)$$

Since the function $F(\dots)$ is a product of $A(t)$ and $f(\dots)$, it also satisfies the above properties ($A(t)$ is not a function of $K(t)$ and $L(t)$) except that

$$F(\lambda A(t), \lambda K(t), \lambda L(t)) > \lambda F(A(t), K(t), L(t)) \quad (7)$$

which determines that $F(\dots)$ exhibits increasing returns in $A(t)$, $K(t)$ and $L(t)$.

Assuming that individual j 's labour time input in production is $l_j(t)$,

$$L(t) = \int_1^{N(t)} l_j(t) dj \quad (8)$$

For simplicity, if the representative individual's labour input is $l(t)$, it becomes

$$L(t) = N(t)l(t) \quad (9)$$

In a neo-classical framework, $A(t)$ is exogenously determined. In this study, it is defined as a function of $E(t)$, the average level of entrepreneurial skill. The specification $A(E(t))$ satisfies the properties $A_E(E(t)) > 0$ and $A_{EE}(E(t)) \geq 0$. Note that the level of entrepreneurial skill in this model does not have an effect on the net contribution of labour time (in $f(\dots)$), but has an effect on total productivity.

If a Cobb-Douglas functional form is chosen for $F(\dots)$ (and therefore for $f(\dots)$), the production technology can be represented by

$$Y(t) = \bar{A} E(t)^\varphi [K(t)]^\alpha [N(t)l(t)]^{1-\alpha} \quad (10)$$

where $\bar{A}$ is a constant, $\alpha \in (0,1)$ and $\varphi \geq 1$. The coefficient φ will determine the degree of increasing returns.

Each individual or dynasty (group of individuals) is a consumer as well as a producer who owns one unit of non-leisure time per period. That individual or dynasty can devote one unit of time to either current production or investment in entrepreneurship so as to increase future consumption. The model assumes that the representative individual allocates $l(t)$ (where $l(t) \in [0,1]$) to current production and $1-l(t)$ to investment in entrepreneurship. The individual maximises the current value of utility derived from consumption of goods over the time horizon

$$\int_0^\infty U(c(t))e^{-\rho t} dt \quad (11)$$

Again, the utility function is well defined and satisfies all the usual properties including $U_c(c(t)) > 0$ and $U_{cc}(c(t)) < 0$. Following Solow (1956), Lucas (1988), Romer (1990) and Caballé and Santos (1993), a utility function with constant elasticity of substitution is chosen in the discussion of equilibrium

$$\int_0^\infty \frac{c(t)^{1-\sigma} - 1}{1-\sigma} e^{-\rho t} dt \quad (12)$$

where $\sigma \in [0,1)$.

To close the model, the mechanism for accumulation of physical capital, $\dot{K}(t)$, and entrepreneurial skill, $\dot{E}(t)$, in the firm are defined. No depreciation of both physical capital and entrepreneurial skill for notational simplicity is assumed. Increases in physical capital stock are determined by the choice of $c(t)$ as all the output less total consumption is invested

$$\dot{K}(t) = Y(t) - N(t)c(t) = A(t)f(K(t), L(t)) - N(t)c(t) \quad (13)$$

If Equation 10 represents the production technology, the above relation becomes

$$\dot{K}(t) = \bar{A} E(t)^\varphi K(t)^\alpha [N(t)l(t)]^{1-\alpha} - N(t)c(t) \quad (14)$$

The production of entrepreneurship is a function of the current stock, $E(t)$, and time input, $1-l(t)$,

$$\dot{E}(t) = g(E(t), 1-l(t)) \quad (15)$$

Again, following Ouzo (1965) and Lucas (1988), a linear relation is assumed for Equation 15 which becomes

$$\dot{E}(t) = \theta E(t)(1 - l(t)) \quad (16)$$

where θ is a positive coefficient. Growth of entrepreneurial skill is proportional to the time spent on accumulation [$\dot{E}/E = \theta(1 - l(t))$].

Equilibrium under central planning

Stylised characteristics of a centrally planned economy are: public ownership is enforced and the state manages all firms; markets are abolished and production/exchange activities and price levels are controlled by the central authority; the planner maximises investment in capital stock which is seen as the source of rapid economic growth and only a minimum proportion of output is handed over to individuals in the form of wage payments; the central planner buys labour time from individuals for current production, pays them according to fixed wage rates and retains the rest of the output for capital investment; and individuals make decisions on the time allocation between current production and investment in entrepreneurship, given the reward structure, to maximise their welfare.

In this system, the important variable setting for the central planner is the decision on the real wage rate (deflated by output price), w , such that

$$c(t) = wl(t) \quad (17)$$

$$Y(t) - wN(t)l(t) \geq 0 \quad (18)$$

It is possible that in the real world $Y(t) - wN(t)l(t) < 0$ for some firms. In such cases the central planner must collect taxes from elsewhere to subsidise these firms. Such special cases, however, are excluded from this study since only firms representative of the economy are being observed.

Individuals then decide on the time allocation which determines total output and accumulation of entrepreneurship. Once this is done, the levels of consumption and physical capital accumulation are simultaneously determined.

For a given w , the optimisation problem for the individual is

$$\max \int_0^{\infty} U(c(t))e^{-\rho t} dt \quad (19)$$

subject to

$$c(t) = wl(t)$$

$$\dot{E}(t) = g(E(t), 1 - l(t))$$

$$c(t) \geq 0, l(t) \in [0, 1], E(t) \geq 0, E(0) = E_0$$

where the control variables are $c(t)$ and $l(t)$ and the state variable is $E(t)$. The two control variables are mutually determined, however, reducing them to one. Considering the specific functional forms of Equations 12 and 16 and substituting Equation 17 into the utility function of Equation 19, the current value Hamiltonian is obtained

$$H = \frac{[wl(t)]^{1-\sigma} - 1}{1-\sigma} + \lambda \theta E(t)(1 - l(t)) \quad (20)$$

where λ is the 'price' used to value increments to entrepreneurial skill. For notational convenience the time argument is suppressed in the following discussion of the equilibrium. This problem can be solved by applying the maximum principle.

PROPOSITION 1: For the problem described by Equation 19, the optimal choice for the individual is to allocate all of one unit of time to current production and to make no investment in entrepreneurship.

PROOF: The optimal choice for an individual is to maximise labour time input in current production, $l^* \equiv 1$. This gives the individual maximum wage income and the highest utility level. Note that $U_h(c(t)) = 0$, i.e., changes in the stock of entrepreneurial skill affects total output but will not alter the level of utility (next period). The fraction of time input is constrained by $l \in [0, 1]$ and $\bar{w} = 1$ is assumed for an illustration. When $l = 0$, $U(\bar{w} * 0) = -1/(1 - \sigma) < 0$ and when $l = 1$, $U(\bar{w} * 1) = 0$. According to the property of the utility function, $U_l > 0$, as l ranges from 0 to 1, the current level of utility moves upward consistently and $l^* \equiv 1$ is the unique solution to the problem.

PROPOSITION 2: Given Proposition 1 and assuming $Y > Nw$, the equilibrium combination of physical capital and entrepreneurial skill is defined by a path along which physical capital stock continues to increase with a constant level of entrepreneurship. The balanced path of output and capital growth is determined by the growth of population, that is, $\dot{Y}/Y = \dot{K}/K = \dot{N}/N = n$. Per capita income stagnates in equilibrium.

PROOF: Since there is no investment in entrepreneurship according to Proposition 1,

$$\dot{E} = \theta E(1 - l) \equiv 0 \quad (21)$$

The level of the average entrepreneurial skill remains at its initial level

$$E \equiv E_0 \quad (22)$$

Again, according to the assumption of the model, the central planner retains $Y - Nw$ and invests it in physical capital. The wage rate is fixed such that

$$Y > Nw \quad (23)$$

Equation 23 holds over time as long as the initial growth rate of output is higher than that of population. Therefore,

$$\frac{\dot{K}}{K} > 0 \quad (24)$$

over time. In equilibrium, the combination of K and E moves along the path with increasing capital stock (Figure 2). Very rapid growth of capital stock and output (remember $\dot{Y}/Y = \alpha(\dot{K}/K) + (1-\alpha)n$) is possible in the initial stage. But no investment in entrepreneurial skills implies no technological progress. The growth rate of output is always lower than capital stock accumulation (but higher than n) in the early stage. This puts an upper limit on further growth of capital stock which in turn pushes down the growth rate of output. The steady-state equilibrium (or the balanced growth path) exists at

$$\frac{\dot{Y}}{Y} = \frac{\dot{K}}{K} = \frac{\dot{N}}{N} = n \text{ (or } n = \alpha n + (1-\alpha)n \text{)} \quad (25)$$

As total output increases at the same rate as population, at equilibrium there will be no growth in per capita income.

Figure 2 Equilibrium combination of physical capital and entrepreneurial skill

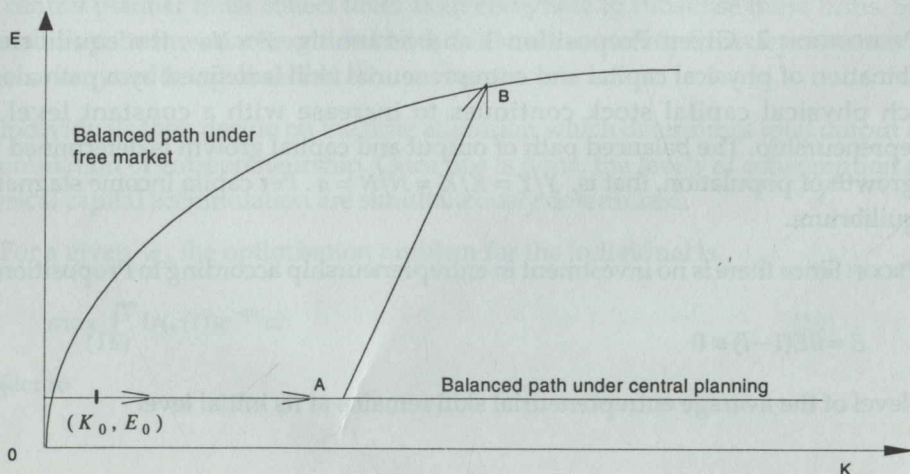


Figure 3 Accumulation of capital stock under central planning

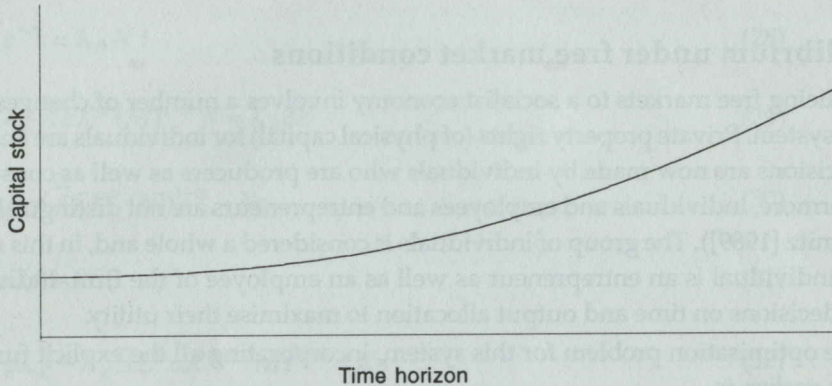
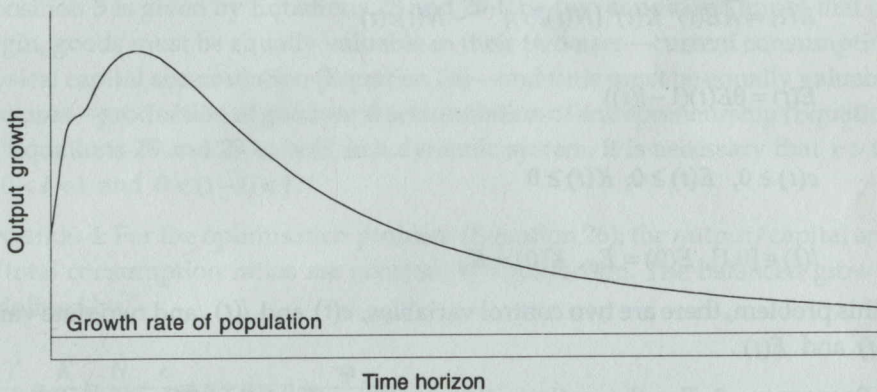


Figure 4 Dynamics of output growth under central planning



The predictions of the model are consistent with the actual growth experiences of many former socialist economies during their periods of central planning. It also provides some explanations of the failure of economic strategies adopted by these socialist countries to promote long-term growth (Figures 3 and 4). The strategy of maximising capital stock to promote economic growth may be successful at the beginning. Capital stock rises dramatically and a high rate of output growth can be achieved (Figures 3 and 4). This, to some extent, explains the extraordinary growth performance of the former Soviet Union and China during their early socialist history. But this high growth cannot be sustained without technological progress (remember

that individuals are not interested in investment in entrepreneurship). The growth rate of output as well as that of capital stock falls quickly towards the steady-state growth rate— n in this case (Figure 4).

Equilibrium under free market conditions

Introducing free markets to a socialist economy involves a number of changes to the above system. Private property rights (of physical capital) for individuals are enforced. All decisions are now made by individuals who are producers as well as consumers. Furthermore, individuals and employees and entrepreneurs are not distinguished (as in Schmitz [1989]). The group of individuals is considered a whole and, in this regard, every individual is an entrepreneur as well as an employee of the firm. Individuals make decisions on time and output allocation to maximise their utility.

The optimisation problem for this system, incorporating all the explicit functions chosen earlier, is

$$\max \int_0^{\infty} \frac{c(t)^{1-\sigma} - 1}{1-\sigma} e^{-\rho t} dt \quad (26)$$

subject to

$$\dot{K}(t) = \bar{A}E(t)^{\theta} K(t)^{\alpha} [N(t)l(t)]^{1-\alpha} - N(t)c(t)$$

$$\dot{E}(t) = \theta E(t)(1-l(t))$$

$$c(t) \geq 0, E(t) \geq 0, K(t) \geq 0$$

$$l(t) \in [0,1], E(0) = E_0, K(0) = K_0$$

In this problem, there are two control variables, $c(t)$ and $l(t)$, and two state variables, $K(t)$ and $E(t)$.

PROPOSITION 3: For the optimisation problem (Equation 26), at equilibrium the individual chooses the level of consumption and investment in entrepreneurship and physical capital such that $c > 0$, $\dot{K} > 0$ and $0 < l < 1$. In other words, the individual chooses to invest in entrepreneurship to facilitate technological progress and maximise utility.

PROOF: Individuals will choose non-zero values for all the control variables. To do this the current value Hamiltonian is

$$H = \frac{c^{1-\sigma} - 1}{1-\sigma} + \lambda_K [\bar{A}E^{\theta} K^{\alpha} (Nl)^{1-\alpha} - Nc] + \lambda_E [\theta E(1-l)] \quad (27)$$

where λ_K and λ_E are 'prices' used to value the increments to stocks of physical capital and entrepreneurial skill. Applying the maximum principle gives the necessary and sufficient conditions for optimal solution

$$c^{-\sigma} = \lambda_K N \quad (28)$$

$$\lambda_K \bar{A} E K^\alpha (Nl)^{1-\alpha} N = \lambda_E \theta E \quad (29)$$

$$\dot{K} = \bar{A} E K^\alpha (Nl)^{1-\alpha} - Nc \quad (30)$$

$$\dot{E}(t) = \theta E(1-l) \quad (31)$$

$$\rho \lambda_K - \lambda_K \bar{A} E^\phi \alpha K^{\alpha-1} (Nl)^{1-\alpha} = \dot{\lambda}_K \quad (32)$$

$$\rho \lambda_E - \lambda_K \bar{A} \phi E^{\phi-1} K^\alpha (Nl)^{1-\alpha} + \lambda_E \theta (1-l) = \dot{\lambda}_E \quad (33)$$

Equations 28–33 can be used to solve for six variables—two control variables, two state variables and two co-state variables.

Proposition 3 is given by Equations 28 and 29. The two conditions imply that on the margin, goods must be equally valuable in their two uses—current consumption and physical capital accumulation (Equation 28)—and time must be equally valuable in its two uses—production of goods and accumulation of entrepreneurship (Equation 29). For Equations 28 and 29 to hold in a dynamic system, it is necessary that $c > 0$, $\dot{K} > 0$, $0 < l < 1$ and $0 < (1-l) < 1$.

PROPOSITION 4: For the optimisation problem (Equation 26), the output/capital and capital/total consumption ratios are constant at equilibrium. The balanced growth path is defined by

$$\frac{\dot{Y}}{Y} = \frac{\dot{K}}{K} = \frac{\dot{N}}{N} + \frac{\dot{c}}{c} = n + u = n + \frac{\phi}{1-\alpha} v$$

where n is the growth rate of population and v is the growth rate of entrepreneurial skills. Furthermore, per capita income grows at $(\phi/(1-\alpha))v$ at equilibrium.

PROOF: Equation 26 can be solved in the same manner as Lucas (1988) and Caballé and Santos (1993). From Equation 28,

$$\sigma \frac{\dot{c}}{c} = N \frac{\dot{\lambda}_K}{\lambda_K} \quad (34)$$

Combining this with Equation 32 gives

that individuals are not interested in investment in entrepreneurship). The growth rate of output as well as that of capital stock falls quickly towards the steady-state growth rate— n in this case (Figure 4).

Equilibrium under free market conditions

Introducing free markets to a socialist economy involves a number of changes to the above system. Private property rights (of physical capital) for individuals are enforced. All decisions are now made by individuals who are producers as well as consumers. Furthermore, individuals and employees and entrepreneurs are not distinguished (as in Schmitz [1989]). The group of individuals is considered a whole and, in this regard, every individual is an entrepreneur as well as an employee of the firm. Individuals make decisions on time and output allocation to maximise their utility.

The optimisation problem for this system, incorporating all the explicit functions chosen earlier, is

$$\max \int_0^{\infty} \frac{c(t)^{1-\sigma} - 1}{1-\sigma} e^{-\rho t} dt \quad (26)$$

subject to

$$\dot{K}(t) = \bar{A}E(t)^{\varphi} K(t)^{\alpha} [N(t)l(t)]^{1-\alpha} - N(t)c(t)$$

$$\dot{E}(t) = \theta E(t)(1-l(t))$$

$$c(t) \geq 0, E(t) \geq 0, K(t) \geq 0$$

$$l(t) \in [0,1], E(0) = E_0, K(0) = K_0$$

In this problem, there are two control variables, $c(t)$ and $l(t)$, and two state variables, $K(t)$ and $E(t)$.

PROPOSITION 3: For the optimisation problem (Equation 26), at equilibrium the individual chooses the level of consumption and investment in entrepreneurship and physical capital such that $c > 0$, $\dot{K} > 0$ and $0 < l < 1$. In other words, the individual chooses to invest in entrepreneurship to facilitate technological progress and maximise utility.

PROOF: Individuals will choose non-zero values for all the control variables. To do this the current value Hamiltonian is

$$H = \frac{c^{1-\sigma} - 1}{1-\sigma} + \lambda_K [\bar{A}E^{\varphi} K^{\alpha} (Nl)^{1-\alpha} - Nc] + \lambda_E [\theta E(1-l)] \quad (27)$$

where λ_K and λ_E are 'prices' used to value the increments to stocks of physical capital and entrepreneurial skill. Applying the maximum principle gives the necessary and sufficient conditions for optimal solution

$$c^{-\sigma} = \lambda_K N \quad (28)$$

$$\lambda_K \bar{A} E K^\alpha (Nl)^{1-\alpha} N = \lambda_E \theta E \quad (29)$$

$$\dot{K} = \bar{A} E K^\alpha (Nl)^{1-\alpha} - Nc \quad (30)$$

$$\dot{E}(t) = \theta E(1-l) \quad (31)$$

$$\rho \lambda_K - \lambda_K \bar{A} E^\phi \alpha K^{\alpha-1} (Nl)^{1-\alpha} = \dot{\lambda}_K \quad (32)$$

$$\rho \lambda_E - \lambda_K \bar{A} \phi E^{\phi-1} K^\alpha (Nl)^{1-\alpha} + \lambda_E \theta(1-l) = \dot{\lambda}_E \quad (33)$$

Equations 28–33 can be used to solve for six variables—two control variables, two state variables and two co-state variables.

Proposition 3 is given by Equations 28 and 29. The two conditions imply that on the margin, goods must be equally valuable in their two uses—current consumption and physical capital accumulation (Equation 28)—and time must be equally valuable in its two uses—production of goods and accumulation of entrepreneurship (Equation 29). For Equations 28 and 29 to hold in a dynamic system, it is necessary that $c > 0$, $\dot{K} > 0$, $0 < l < 1$ and $0 < (1-l) < 1$.

PROPOSITION 4: For the optimisation problem (Equation 26), the output/capital and capital/total consumption ratios are constant at equilibrium. The balanced growth path is defined by

$$\frac{\dot{Y}}{Y} = \frac{\dot{K}}{K} = \frac{\dot{N}}{N} + \frac{\dot{c}}{c} = n + u = n + \frac{\phi}{1-\alpha} v$$

where n is the growth rate of population and v is the growth rate of entrepreneurial skills. Furthermore, per capita income grows at $(\phi/(1-\alpha))v$ at equilibrium.

PROOF: Equation 26 can be solved in the same manner as Lucas (1988) and Caballé and Santos (1993). From Equation 28,

$$\sigma \frac{\dot{c}}{c} = N \frac{\dot{\lambda}_K}{\lambda_K} \quad (34)$$

Combining this with Equation 32 gives

$$\rho + \sigma \frac{\dot{c}}{c} = \alpha \bar{A} E^{\varphi} K^{\alpha-1} (NI)^{1-\alpha} \quad (35)$$

suggesting that, along the balanced path, the marginal product of capital must be a constant, since $\dot{c}/c$ is a constant in equilibrium (u). Because a Cobb-Douglas function is adopted in this model, the output/capital ratio must be constant (as the marginal product equals α times the average product Y/K). Then output and capital stock must grow at the same rate in equilibrium. Furthermore, total consumption grows at that equilibrium rate as well. To arrive at this, divide Equation 14 by K and use the information from Equation 35

$$\frac{Nc}{K} + \frac{\dot{K}}{K} = Ah^{\varphi} K^{\alpha-1} (NI)^{1-\alpha} = \frac{\rho + \sigma u}{\alpha} \quad (36)$$

$\dot{K}/K$ is a constant in equilibrium, so total consumption and capital stock is also constant on the balanced growth path. Differentiating $K = BNc$ gives (B is a positive number indicating the ratio between capital stock and total consumption)

$$\frac{\dot{K}}{K} = \frac{\dot{N}}{N} + \frac{\dot{c}}{c} = n + u \quad (37)$$

The equilibrium growth of entrepreneurial skill is determined by its accumulation mechanism once the fraction of time devoted to current production, l^* , is determined

$$\frac{\dot{E}}{E} = \theta(1 - l^*) = v \quad (38)$$

In the long run, under free market institutions both output and physical capital grow faster than population—the equilibrium rate under central planning. How much faster depends on the magnitude of u . By differentiating Equation 36,

$$u = \frac{\varphi}{1-\alpha} v \left\{ = \frac{\varphi\theta}{1-\alpha} (1 - l^*) \right\} \quad (39)$$

is a function of the growth rate of entrepreneurial skill and the coefficient $\varphi/(1-\alpha)$ (always greater than one). Since total output grows at $n + u$, per capita income increases at the rate of $u = (\varphi/(1-\alpha))v$ in equilibrium.

Changes in the combination of physical capital and entrepreneurial skill can be illustrated diagrammatically by a concave curve along the balanced path (Figure 2). Figure 2 also provides some indication of the possible transition from a central planning equilibrium to a free market equilibrium. The central planning equilibrium (Point A) has the characteristics of a high proportion of physical capital to entrepreneurial skill, as well as a point of low growth rate. The stock of entrepreneurial skill is very low. In such an economy, the potential return to increments of entrepreneurial skill must be very high. Movement from this low growth equilibrium to a market equilibrium therefore first involves dramatic development of entrepreneurship, although the

physical capital stock is likely to accumulate rapidly as well. Once equilibrium is reached, the economy will move along the balanced growth path under free market institutions.

Institutional transition and long-run growth

This study has identified two distinct economic institutions—central planning and the free market—and investigated the implications of these different institutions for achieving long-run growth. An endogenous growth model is constructed in which investment in entrepreneurship is the primary engine of growth.

Under the stylised central planning institution, individuals do not have incentives to invest in the development of entrepreneurial skills. They tend to allocate all of their non-leisure time to current production to maximise wage incomes. The stock of entrepreneurial skills, therefore, does not change over time. On the other hand, motivated by prevailing heavy industry-oriented development strategies, the government seeks to maximise investment in physical capital. The model suggests that the central planner may be able to manage a relatively short period of rapid increases in capital stock and rapid growth of output. With given technology and constant returns to primary factors (labour and capital), however, this rapid growth cannot be sustained. The growth rates of output and capital fall towards the growth rate of population over time—the equilibrium at which per capita income stagnates.

After the introduction of the free market, it is assumed that individuals capture all returns to their endowed labour time, capital stock and entrepreneurial skills. In the pursuit of maximum lifetime utility, individuals invest optimally in both physical capital and entrepreneurial skills. Accumulation of entrepreneurial skills facilitates technological progress and raises productivity. Along the balanced growth path, output, capital stock and consumption all grow at the same rate above the rate of population growth. Per capita income grows over time.

The simple conclusion of this paper is that economic reforms in transitional economies can eliminate inefficiency and lift their growth rates of output and income to higher levels after the transition. The results of the model are consistent with the growth experiences of the transitional economies.

This optimistic conclusion comes with qualifications. First, economic institutions adopted by most socialist economies damaged their long-run growth potential. A more conservative conclusion would be that capital accumulation by itself is not enough to sustain high growth and that any institution that discourages investment in entrepreneurship would fail to stimulate long-run growth. In the theoretical development, however, no attempt was made to discard the idea of central planning, but it was incorporated in the transition within the model.

Second, the finding of no investment in entrepreneurial skills under central planning does not imply that there was no accumulation of human capital at all. Apart from the development of science and technology in many former centrally planned economies, individuals were keen to obtain higher levels of formal education. Formal education was in fact one of the very limited avenues through which individuals could gain higher incomes. This is ignored in the model for two reasons. First, there is not sufficient evidence of a positive relationship between the levels of formal education and productivity in the centrally planned economies because individuals did not have any incentives to utilise their human capital in production. Second, the skill-related wage differentials are set at the beginning of each individual's employment life and often just did not change. Human capital accumulated through experience should change an individual's productivity. But since the model assumes a representative individual, the conclusions should remain the same. Assuming that the rate of human capital accumulation through experience is b , the only change would be that the equilibrium growth rate for output and capital is $n+b$ instead of n . The equilibrium growth rate under the free market then becomes $n+b+u$.

Finally, the model does not predict that every transitional economy will reach a high growth equilibrium automatically after the transition. The model is abstract while the real world is complex. Otherwise it would not be possible to explain why growth rates vary substantially across market economies. What this paper suggests is that the on-going institutional transition provides each economy with the potential to achieve a higher rate of long-run growth. Due to various factors and constraints, some transitional economies may reach a high growth equilibrium sooner, some later and others may not be able to get there at all.

These conclusions and qualifications suggest some directions for future research. One direction points to the investigation of other potential mechanisms determining long-run growth under central planning and free market institutions. This paper only considers investment in entrepreneurship. A worthwhile question to ask is whether or not there are any other important mechanisms which may work either in the same direction or in the opposite direction to the above mechanism. Another direction, given the conclusions of this study, is to explore the transitional dynamics from the low growth equilibrium under central planning to the high growth equilibrium under the free market. Theoretically there might be numerous paths for the transition—some may lead to high growth while others may lead to growth traps. In particular, what are the implications of the two distinct approaches to economic reform—gradualism and 'shock therapy'—for growth transition? Yet another important direction is to examine the policy implications for long-run growth in line with the usual exercises of the endogenous growth literature. It also would be valuable to identify policies that will facilitate a smooth transition to a high growth equilibrium.

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