Institutionally Induced Human Capital Vintages and Economic Growth in Transition

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INSTITUTIONALLY INDUCED HUMAN CAPITAL VINTAGES AND ECONOMIC GROWTH IN TRANSITION

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In this paper we introduce additional parameters of the economic environment related to some notion of "distance" to institutions in a simple formal model. This distance could be viewed as an uneven spatial distribution (or coverage) of institutions with respect to population distribution. We are led to conclude here that distance to institutions is an important determinant of the emergence of heterogeneous (vintage) human capital. Our modeling framework also shows, that the existence of uneven access (or distance) to institutions leads to important implications concerning economic growth.

Keywords: **Vintage human capital, distance to institutions, economic growth, transition economies.**

1. INTRODUCTION

The theories of economic growth traditionally view capital and labor as homogeneous factors,[1] while any improvements in their quality are attributed to a disembodied technology term in the macroeconomic production function. The arrival of new technologies affects all capital and labor units – old and new – in the same way. Thus, the fact that the newer units are generally of better quality, or possess higher productivity, is easily neglected. Growth empirics have shown

[1] Homogeneity of factors concerns their quality, respectively their productivity.

that a significant part of economic growth is attributed to the technology term.[2] The latter is often modeled as a residual or as a deterministic trend, which in practice carries no valuable information for the explanation of the 'real' sources of growth.[3] The use of this approach has led eventually to a situation, in which economics is trying to explain a part of economic growth by means of a factor that itself has remained largely unexplained.

In order to overcome this type of deficiencies of the above approach, some authors have developed the idea of technological progress embodied in the factors of production (in particular physical and human capital), thus yielding different 'vintages' of each one of them. While the vintage approach has been applied relatively more extensively to physical capital,[4] the studies on vintage human capital are still far from numerous.

The vintage approach is applied for the first time to human capital in Sen (1966). There a simple model is developed, in which the idea that all labor units can uniformly, automatically and completely acquire the newly emerged knowledge is rejected. The author suggests that there are two ways of human capital accumulation in each individual – formal education, and learning-by-doing. One of his key assumptions is that the education system constantly improves in time, which leads to better-educated young workers compared to those who have completed their education in earlier years. At the same time the old workers possess more work experience and better skills acquired in the learning-by-doing process in comparison with the younger workers. Both formal education and learning-by-doing exert influence on the productive ability and productivity of all individuals. Since there are, on the one hand, workers of different age and on the other the ability to learn varies across workers' generations, different vintages of human capital emerge within the labor force. The human capital defined in this fashion embodies the technical knowledge. Regarding the productive ability and age of workers having the same number of years of education, Sen concludes that there is a diminishing marginal increase in productive ability with respect to age and the productive ability is ever-increasing, ever-

[2] See, for example, Solow (1957), Jorgenson and Griliches (1967), Barro and Sala-i-Martin (2004), pp. 438-441, etc.

[3] Abramovitz (1962, p. 764) refers to the technology residual as "a measure of ignorance".

[4] See, for example, Johansen (1959), Solow (1962), Solow et. al. (1966), Hu (1972), Gordon (1973), Kónya (1994), Greenwood, Hercowitz and Krusell (1997), Jovanovic (1998), Boucekkine, del Rio and Licandro (1999), Iacopetta (2002), Boucekkine, de la Croix and Licandro (2006), etc.

decreasing, or has a single peak.

Chari and Hopenhayn (1991) present a dynamic overlapping-generations general equilibrium framework, in which human capital is accumulated through learning-by-doing. In each generation there exist various vintages of human capital. There is only one type of capital (human capital), which is technology-specific. Old capital and new capital co-exist and are used as complements. The new (and better) technologies arrive exogenously and continually in the economy, but there is no instantaneous creative destruction, i.e. there is gradual diffusion of new productive knowledge. Under such assumptions, the authors show that the rate of diffusion of new technologies, and consequently economic growth, depends on the distribution of skilled labor across vintages and the (expected) relative superiority of new technologies compared to the existing ones. An increased arrival rate of new technologies leads to a shift in the skilled labor distribution to newer vintages and consequentially accelerates technological diffusion.

In a modification of Chari and Hopenhayn's model, Franco and Ingram (2006) reach the conclusion that technological advances are a consequence of better-educated labor, faster technology diffusion, and flatter wage profiles of workers. In addition to Chari and Hopenhayn's assumption that human capital vintages are a result of learning-by-doing, Franco and Ingram assume (similarly to Sen) that there is a second channel of skill quantity and quality differentiation – formal schooling.

Boucekkine, de la Croix and Licandro (2000) also construct an overlapping-generations model in which endogenous economic growth is driven by the accumulation of generation-specific human capital.[5] The main focus of the authors is the relation of human capital accumulation to the demographic characteristics (e.g. longevity, death rate, education, etc.) in the population and the resulting implications for growth.

While the importance of the characteristics of vintage human capital that the above reviewed studies consider is undisputable, they possess a common feature, which in a certain way neglects important characteristics of the social and economic environment. All those studies assume that human capital formation is a consequence of the optimal behavior of individuals who choose the

[5] Unlike Chari and Hopenhayn, each human capital vintage is identified with a particular unique generation.

duration of their studies, i.e. the target level of their educational attainment. Traditionally the models of human capital treat the family environment as a key factor affecting the initial conditions and constraints of the optimization framework of the individual.[6] This micro-based approach, however, does not account for the fact that the accumulation of human capital, and the creation of new knowledge in general within each generation takes place under a (possibly) different social and institutional setting.

In this paper we assume that institutions are an important determinant of human capital and are therefore of key importance to economic growth. Of course, the idea that the institutions are one of the main driving forces behind growth is not new. The theoretical branches that support this kind of view consider institutions as having a direct impact on economic performance. They stress the importance of institutions as rules and constraints that determine human actions and interactions.[7] We accept this setting, while we expand the idea to account for the fact that the rules and constraints that are represented by the institutions are also very important for the rate of accumulation and quality of human capital. In other words, the influence on economic performance exerted by institutions is not direct but an indirect one – it is realized only after the corresponding quantity and quality of human capital accumulates. Also, institutions not only provide incentives for the creation of human capital, but also act as a direct engine responsible for its accumulation.

2. HUMAN CAPITAL AND INSTITUTIONS – SOME REMARKS

It is a general observation that human capital accumulation is a process that has a number of personal and environment determinants. Natural intellectual abilities, for example, are a personal characteristic, which in a way acts as a 'starting value' and plays an important role in the final outcome related to human capital. Family environment and more specifically the human capital of parents is also very important. But institutions (for example, the schooling system) are not less important.

[6] See for example Becker (1993).

[7] For a thorough discussion, see for example North (1990).

According to North and Thomas (1973) factor accumulation and education (and therefore human capital accumulation) do not cause growth but are themselves indicative of growth. In their opinion, the institutions are the key determinant of growth and therefore the income differences across countries and regions should be explained by the differences in institutions.

The recent economic literature has provided sufficiently strong evidence that factor accumulation including human capital is indeed a cause of economic growth.[8] This does not come, however, to reject the possibility that growth itself can cause additional investment and schooling.

The importance of the 'institutions - human capital' interrelation for growth is emphasized even in the literature, in which the empirical results do not provide evidence for the presence of influence of human capital on growth. Pritchett (1996), for example, explains the absence of a relationship between human capital and growth by the existence of institutional rigidities, which prevent the human capital from being efficiently utilized in the economy.[9]

Acemoglu, Johnson and Robinson (2004) study the sources of economic growth and the role of institutions for growth. They reach the strong conclusion that the institutions affect the process of factor accumulation including human capital. The authors make a distinction between political and economic institutions and define the direction in which they interact: political institutions determine economic institutions and they in turn determine the economic performance of a country for a given period of time. The political institution possess an important characteristic – they are durable, and significant changes in them occur only during times of major reforms such as transitions from dictatorship to democracy and from a centrally-planned to a market-based economy.

Some empirical studies also confirm the impact of institutions on economic growth. Hall and Jones (1999), for example, come to the conclusion that the cross-country variation in output per worker is determined by differences in institutions and government policies along with the differences in physical capital and educational attainment. Alesina and Perotti (1994) show that the presence of established democratic institutions in a country promotes economic development.

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[8] See, for example, Mankiw, Romer and Weil (1991), Barro and Sala-i-Martin (2004), Temple (2001), etc.

[9] The other two explanations suggested by Pritchett are that the quality of education is low and the human capital created is less than perceived, or the demand for educated labor cannot meet the higher supply.

Although the above-cited studies (and many others) provide evidence on the importance of institutions for growth, their evidence is primarily indirect and their conclusions do not rest upon a strict and generally-accepted modeling framework. There is no unified theoretical treatment and quantification of institutions in growth models.

3. HOW INSTITUTIONS SHAPE DIFFERENT HUMAN CAPITAL VINTAGES

The emergence of institutions in fact has never been instantaneous. It took years, decades and even centuries before some informal group rules were institutionalized. It took even additional time before those institutions got firmly established in larger groups and societies. The legislative systems that characterize modern developed societies are based on millennial heritage and can be traced back even as early as Roman times. Modern religions are based (at least partly) on religious beliefs of ancient civilizations, some of which do not exist any longer. Other examples could also be provided easily.

It needs to be mentioned also that institutions are almost never established without opposition. There are virtually no rules that can suit all members of society, and there is the natural strife of individuals to gain advantage of the rest by evading or twisting rules. Therefore, the success of institutions strongly depends on their acceptance among society groups and their universal applicability.

Establishing and running of institutions requires, beside group consent, efforts and, more importantly, funding. The greater the population and territory that have to be covered the larger the funds that have to be made available. Such funding is always provided through some form of taxation of society, and eventually situations can arise in which needs overwhelm funding opportunities. In such situations the fluent functioning of institutions is not secured.

Whenever funding does not meet all needs for institutional building and maintenance, there are various possibilities concerning the quality of institutional operation. Institutions can function equally improperly everywhere, or they could function properly at some places and malfunction at other. In other words, institutions can vary in their spatial coverage. We will provide several examples in this direction.

The first example is related to public administration, which in some countries is highly

centralized in only a few large cities. In such occasions the institution would be more beneficial to citizens living in those cities and would be reached with greater difficulties by citizens living outside those cities if population mobility is low, for instance.

A second example relates to situations, in which some city areas are with substantially lower police coverage than others, and in those areas higher crime rates are observed. Similar situations (though not related to crime rates) exist with respect to healthcare coverage, construction supervision, etc.

Another example covers the cases when information on the services provided by institutions is either not publicly available to everyone or is highly asymmetrical and induces different kinds of beneficiaries' responses and reactions. Such instances include the access of various society groups, such as minorities, marginal groups and other socially excluded persons, to institutional services.

The same situation appears with research centers, which can be accessed only by a limited number of users of scientific output due to patent restrictions, knowledge gaps, prohibitive prices of access, etc.

In fact, the uneven distribution in space of institutional coverage affects many economic and social processes including the process of human capital formation and accumulation. We could generalize that although there are institutions of a certain kind, there might be certain factors related to location, information availability, personal skills and abilities, etc., which can lead to varying effects on different individuals. This generalization brings the message that there could be defined some additional parameters of the economic environment, which at some point could be used to overcome the deficiencies of the available growth empirics. In a sense all those parameters are related to some notion of "distance" to institutions – equally, this distance could be viewed as an uneven spatial distribution (or coverage) of institutions with respect to population distribution.[10]

We are led to conclude here that distance to institutions defined in the above sense is one of the

[10] Also, in even more formal terms, if the maximum distance is normalized to 1, we could also view the distance d as the probability of not receiving service, and $1-d$ as the probability of being serviced by institutions.

most important determinants of the emergence of heterogeneous human capital, i.e. of human capital vintages. Moreover, the longer the distance to institutions remains different for different society groups in time, the larger the differences between the various human capital vintages, represented largely by those groups, become.

The existence of different distances to institutions per individual also has a major implication for income inequality. Since the higher level of human capital is associated with higher incomes, larger distances to institutions lead to worsened opportunities for human capital accumulation and consequently to lower incomes of the respective society group compared to those who are closer to the institutions.

When is the emergence of different distances between individuals and institutions more likely? There are mainly two cases: first, it is when institutions are 'young', i.e. at the time when they are established; and second, at the time when they undergo major changes. The process of transition from a centrally planned to a market-based economy and from a totalitarian to a democratic society in the countries of the former Eastern Block is very illustrative as an example of both of these cases. Many institutions in those countries did not exist during communism and were established only after the beginning of transition.[11] Others did actually exist but needed to be thoroughly reformed in order to meet the needs and requirements of the new political and economic environment.[12] The fact that the newly-established institutions and the reformed ones were neither instantaneously available at equal cost to all the population, nor they were accepted in a unanimous way by all the people, acted (and to some extent still acts) as an important driving force which led to the creation of different human capital vintages.

Although the two cases are formally distinct, they share most of their features since they create in a similar way distance to different individuals. Therefore, as a first proxy, they can be modeled in an equal fashion.

[11] Such as private property of land and capital (although certain variations across communist countries did exist), private schooling, free markets, etc.

[12] Examples include banking and other financial institutions, courts, government, etc.

4. SETTING UP A BASIC MODELING FRAMEWORK

We will assume that production can be described with the following production function having the neo-classical properties:

$$Y_t = F(K_t, H_t), \tag{1}$$

where Y is output produced, K is physical capital (machines, equipment, buildings, etc.), and H is human capital. Human capital is defined generally as the labor force augmented by the productive abilities stemming from formal schooling and working experience, i.e. learning-by-doing.[13] The labor force consists of n society groups of individuals, and the i-th group is characterized with human capital h_i.[14] We assume that all knowledge is embodied in human capital, and the different levels of knowledge are reflected in different human capital vintages. Time is denoted by t and is continuous. Obviously,

$$H_t = \sum_{i=1}^{n} h_{it}. \tag{2}$$

We will also assume that $h_{it} \neq h_{jt},\ i \neq j$, i.e. each social group is identified with a different human capital vintage.[15]

The dynamics of aggregate physical capital is governed by the equation:

$$\dot{K}_t = I_t - \delta K_t, \tag{3}$$

where I_t is gross investment in physical capital and δ is the rate of depreciation of physical capital.[16] In order to focus on the effects of vintage human capital on economic growth, here we

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[13] The definition is not affecting any of the model characteristics and thus can easily be modified to suit specific modeling needs.

[14] This means that each individual in the group has h_i / l_i human capital, where l_i is the number of individuals in the group; $\sum_{i=1}^{n} l_i = L$ or the total number of the population.

[15] Within each group all individual has the same amount of human capital as the other group members. See the previous footnote.

[16] As usual, dots over variables denote derivatives with respect to time.

will assume that the quantity of physical capital in the economy remains constant in time, i.e. $\dot{K}_t = 0$, which means that the aggregate income is a function only of human capital:[17]

$$Y_t = F(H_t) \tag{4}$$

The human capital accumulation of each society group is equal to:

$$\dot{h}_{it} = e^{-\gamma \cdot d_{it} + c_i} + b_i \cdot y_{it}, \quad \gamma > 0, \tag{5}$$

where d_{it} is a measure of the distance between group i and the institution at time t, and b_i is the share of group i's income invested in human capital at time t.

We assume no taxes in the model. Therefore, there is no public investment in capital (including human capital); all investments are directly funded out of individual incomes. The decision how much to invest in human capital is not taken by institutions but only by individuals. The decision is taken at the initial time point, after which the ratio of investment in human capital to income is fixed.

The income of the i-th group itself is a function of the human capital of the group:

$$y_{it} = f(h_{it}) \tag{6}$$

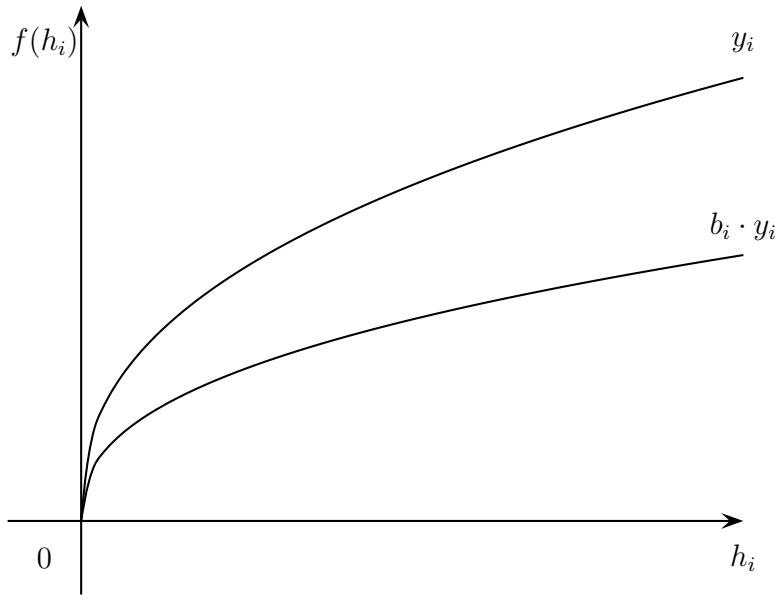
having the following properties:

$$f'(h_{it}) > 0, \forall i, \quad f''(h_{it}) < 0, \forall i$$

This functional dependence is displayed in Figure 1.

[17] This is only a simplification for greater clarity of the exposition. The true variability of physical capital introduces additional complexity, which has been purposefully avoided here. Moreover, physical capital could also be characterized by different vintages, each of which would have its own dynamics.

Figure 1: Income of a society group as a function of its human capital



The convexity of the function has the following economic interpretation: the income of the i-th group increases with the increase in its human capital but at a decreasing rate, i.e. there are diminishing returns to education.

Equation (5) suggests that we assume no depreciation of human capital. We also have:

$$\lim_{d_{it} \to 0} \dot{h}_{it} = e^{c_i} + b_i y_{it} \tag{7}$$

This expression gives us the maximum attainable human capital of group i when the distance to the institution is zero. The positive coefficient c_i reflects all group-specific characteristics (besides the share of income invested in human capital accumulation), which contribute to the accumulation of human capital in the respective individual.[18] In other words, the full access to institutions has the highest possible positive effect on human capital, which is added to the effect from investing a share of income.

The combined interpretation of equations (5) and (7) suggests also that the distance to institutions is a substantial factor that could weaken or even eliminate the positive effect of natural abilities

[18] The characteristics include natural abilities, family environment, etc.

on human capital accumulation.[19]

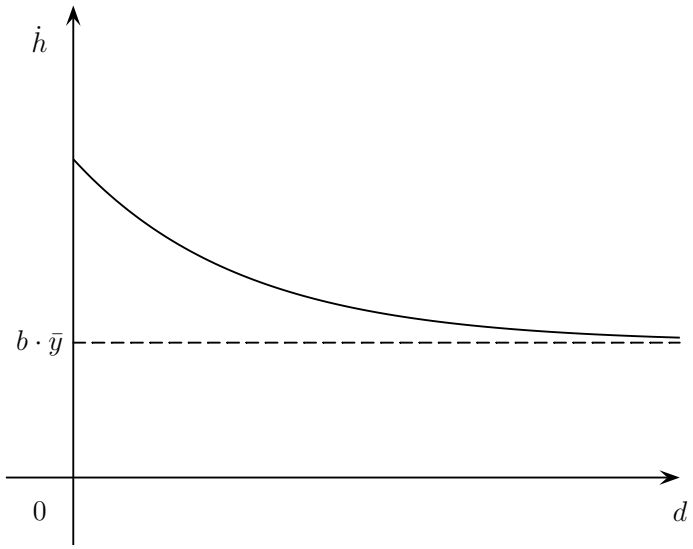
The limit:

(8) $$\lim_{d_{it} \to +\infty} \dot{h}_{it} = b_i y_{it}$$

shows the case when the distance to the institution is infinite, or equally when there is no institution. In this case human capital is equal only to the invested share of individual income.

The dynamics of human capital as a function of distance to institutions is displayed in Figure 2, where the level of income has been fixed to $\overline{y}$ (meaning that the investment in human capital is $b \cdot \overline{y}$ in that case).

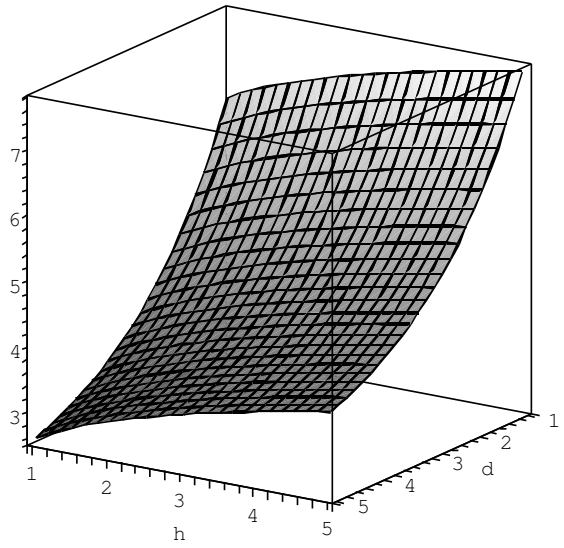
Figure 2: Dynamics of human capital as a function of distance to institutions



Figures 1 and 2 are combined in Figure 3, showing the dynamics of human capital (on the vertical axis) as a function of distance to institutions and of variability in income (itself being a function of human capital, h).

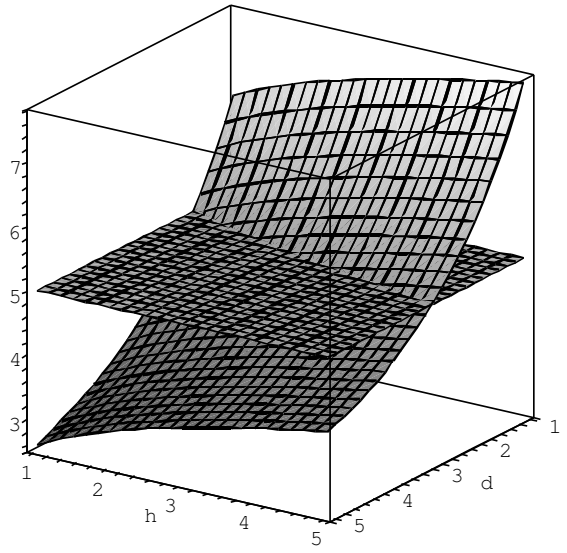
[19] For instance, imagine what would have become of W. A. Mozart if he was not born in Salzburg, in the family of a musician, but in Sofia, in the family of a farmer, and never had access to the Austrian royal court...

Figure 3: Dynamics of human capital (on vertical axis)



Equation (5) and Figure 3 show that if we start with homogeneous (or the easier case with zero) human capital across all individuals, a vintage is formed through different speeds of human capital accumulation. Thus, society groups (as defined earlier in the text) are formed and are identified graphically with the intersection of the surface defined by equation (5) and the plane defined by $\dot{h}_i = q_i$, where q_i is a constant for each fixed i (See Figure 4).

Figure 4: Graphical definition of a vintage of human capital when the initial human capital is homogeneous across individuals



Assuming that human capital formation in each society group is independent from that in other groups, differentiating equation (2) with respect to time, we have:

$$\dot{H}_t = \sum_{i=1}^{n} \dot{h}_{it} = \sum_{i=1}^{n} (e^{-\gamma \cdot d_{it} + c_i} + b_i \cdot y_{it}) \tag{9}$$

From a mathematical point of view, the model attains a steady state (equilibrium) when $\dot{H}_t = 0$. However, such a situation is possible only under the simultaneous presence of all of the following circumstances:

- $\lim d_{it} = +\infty, \forall i$ - i.e. when all individuals have no access to institutions, or equally, when there are no institutions;
- $b_i = 0, \forall i$ - i.e. when all individuals make no investments in human capital.

Since the two conditions are never met in reality[20], the model suggests that human capital is

[20] The presence of institutions (irrespective of their quality and coverage) and the accumulation of knowledge (irrespective of its quantity, as long as it is only positive) are indispensable characteristics of all known civilizations.

always increasing. As a consequence, the model is characterized by endogenously generated long-term economic growth which never ceases.

For a fixed level of investments in human capital, the highest rate of economic growth is a solution to the problem:

$$\max_{d_{it}} \sum_{i=1}^{n} (e^{-\gamma \cdot d_{it} + c_i} + b_i \cdot y_{it}) = \sum_{i=1}^{n} (e^{c_i} + b_i \cdot y_{it}), \tag{10}$$

i.e. when $d_{it} = 0, \forall i$ (all individuals have full access to the institutions).

5. MAJOR CONCLUSIONS AND POSSIBLE EXTENSIONS OF THE MODEL

So far we developed a simple model in an attempt to explain the combined influence of investments in human capital and institutional availability on economic growth. Our analysis was based on the assumption that the individuals in an economy do not have the same access to institutions and the services they provide. As a consequence, different human capital vintages may be induced. We commented that different 'distances' between institutions and individuals emerge most often in two instances: when institutions are established, and when there are substantial changes in them. Both cases are a typical feature of economies in transition.

The changing institutional environment can be used to explain the slower than expected growth recovery in the years after the start of transition. The differences in the distances to institutions or the longer-lasting distances can be used as a possible explanation of why growth has been slower in some transition countries and faster in others.

The major implications of the model are as follows:

- The larger the investment in human capital, the higher the rate of economic growth;
- The higher the variety in distances, the larger the number of vintages;
- The larger the distance to institutions, the smaller the additional positive effect of natural abilities on human capital accumulation, respectively on growth;
- The highest positive effect on growth is attained when the distances between institutions and individuals are all eliminated.

The model can be extended in various directions. A first extension would be if taxation is introduced, a possibility for public policies would be available. Those public policies could serve two basic functions related to human capital formation:

1) Since taxes perform an income redistribution function among society members, tax revenues could be directed to lower-income groups to aid them with their investment in human capital accumulation;

2) A share of tax revenue can be directed at building, strengthening and higher spatial coverage of institutions in order to bring them closer to those members of society who are deprived of full access to them;

A second extension could introduce physical capital variability. Moreover, this extension could include physical capital heterogeneity, i.e. the emergence and existence of various physical capital vintages. The major restriction for the latter lies in the way, in which physical and human capital vintage would interact among each other in the process of income generation.

Another extension possibility lies in finding the way in which individuals determine their optimal rates of consumption, investment in physical capital, and investment in human capital. The restrictions of such an approach seem to be the most numerous and complex. First, since there are various vintages the concept of a representative consumer (or household) would be inappropriate. Instead, there would be as many representative consumers as the number of vintages is. Second, there would be also various utility functions and various future discount rates based on subjective beliefs stemming from the asymmetry in information. Also, the way in which the various vintages interact among themselves would probably be important in the way beliefs and utility functions are formed (and perhaps some game theoretical element would need to be introduced in this relation).

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