INSTITUTIONAL CHANGE AND ECONOMIC DEVELOPMENT: WHAT COMES FIRST?

THE CASE OF TRANSITION COUNTRIES

by

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Abstract

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This thesis investigates the importance of developing market-enhancing institutions for economic performance of post-communist countries. Although the concept of institutions is vague and difficult to measure, I use a recent data set to identify the key elements of the "institutional matrix" in transition economies. The problems of subjectivity and endogeneity of obtained institutional measures are addressed. Cross-sectional time-series analysis of the 26 post-communist countries is used to disentangle the high correlation between institutional quality and income per capita into a two-way possible influence. The results of the study support a positive direct impact of good institutional quality on income per capita. However, a negative feedback impact of income per capita on institutional quality is found for transition economies during 1996-2002 years. The latter finding has a theoretical justification in terms of state capture and institutional lock-in that take place in some post-communist countries during considered period. This suggests that economic development will not automatically result in the improvement of proper institutions.

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GLOSSARY

Institutions. Humanly devised constrains created to reduce uncertainty, to make order, and provide incentive structure of the economy. They can be formal (laws, constitutions, property rights) and informal (sanctions, taboos, customs, traditions, codes of conduct).

Transition Year. A year in which communist regime collapsed and "the country began to move towards the market economy" (Fisher and Sahay, 2000).

Governance Cluster. An aggregate indicator which includes measures of a similar underlying concept of institutional quality (governance).

Chapter 1

INTRODUCTION

From the very beginning of transition, in the early 1990s, conventional wisdom suggested that there would be a complex process of transformation of post-communist countries into the countries with market economy. Almost at once, 27 states made their first steps on the road to a new system of functioning. How successful this journey could be for each particular country, evidence says – depends heavily on the country itself.

On the diverse economic map of post-communist area, one can distinguish successful stories of this transformation: Poland, Hungary, Czech Republic, Baltic countries, from not very successful: the majority of the Former Soviet Union countries. Moreover, such difference in economic performance has been officially recognized after 8 transition states enter the European Union. Not surprisingly, the latter countries are the ones that are situated closer to Western Europe. Does this proximity to Western Europe have a crucial role in determining the future economic performance since the beginning of transformation? Does the level of initial conditions, human capital and infrastructure endowments can explain this significant gap in the economic development among the transitions economies?

The answer to these not easy questions can be positive. But it would be naïve to rely only on these arguments while debating and trying to find excuses for the current poor state of well-being. One vivid example is Ukraine. The country, with good initial conditions, huge potential in resources, good infrastructure and high level of human capital, has reached positive rates of growth only in recent

years. This example suggests that what has to be explained is not the failure of the main economic prerequisites that should provide sustainable growth, but some underlying phenomena that hinder these prerequisites to fulfill their role in the conventional economic theory.

It is widely recognized that among these underlying phenomena that creates the incentive structure of the whole economy are institutions. Institutions are in the sense of "humanly-devised constraints that structure human interaction" (North, 1991). By influencing transformation and transaction costs, institutions indirectly enter in the production process thus affecting the economic performance. Now even "the most convinced neoclassical economist" believes that institutions matter, and disregarding them will lead to the above mentioned "puzzle" of not finding the appropriate explanations to actual facts.

After incorporating the institutions into the economic analysis, it becomes evident that it was erroneously thought that a market economy must be inherently more efficient than a centrally planned one. And it was taken for granted that "the opening markets would bring with it rather quickly and painlessly the needed institutions to make the new system work properly" (Hare, 2001). From this perspective, one can argue that EU-accession countries had more appropriate institutions for the market economy than Former Soviet Union countries, which can be partially explained by the quality of inherited "market memory" in their societies.

The purpose of this paper is to highlight the importance of institutions for the economic performance in transition countries, survey the possible measurements of institutional quality for transition countries and propose an empirical methodology to capture the importance of institutional change by employing dynamic panel data analysis. Finally, this work will elaborate on the separation of

the high correlation between income per capita and institutional quality into a two-way channel of influence. Low or even negative impact of income on institutional quality for the transition countries is found and theoretical explanations to this finding are discussed.

The remainder of the thesis is organized as follows. In chapter 2 a survey of research studies, which address the question of economic importance of institutions, is provided. Chapter 3 elaborates on the theoretical growth model that enables to highlight possible channels of institutions' influence. Later, an empirical model is estimated through construction of structural system of equations. Finally, we conclude with a brief discussion of obtained results and propose policy implications.

C h a p t e r 2

SURVEY OF LITERATURE ON THE ECONOMIC IMPORTANCE OF INSTITUTIONS

We cannot see, feel, touch, or even measure institutions;
They are constructs of the human mind. But even the most
convinced neoclassical economists admit their existence and
typically make them parameters (implicitly or explicitly) in their models.
North, 1990

In the fundamental work of one of the greatest institutional economist (North, 1990), institutions are addressed for the first time with thorough analysis of their possible channels of influence on economic performance. Institutions are everywhere, and ignoring them would lead to incompleteness of conclusions and policy implications.

Economic performance depends on transformation and transaction cost of production. Institutions enter through shaping the incentives structure of the economy, and are explicitly involved in the determination of transaction and transformation costs of any economic activity. Institutions affect transformation costs through influencing the technology used; and they affect transaction costs because there is a direct link between the character and quality of institutions and such costs.

North (1990, p.65) gives an illustrative example of the impressive consequences of poorly defined and ineffective institutions in contrasting the performance of the Third World economies to the advanced economies. Such problems as the

inability to get spare parts or a two-year wait to get a telephone installed will surely result in different organization of productive activity. A good remedy could exist in the form of bribes for quick delivery and rapid telephone installation, but resultant shadow transaction costs will significantly alter relative prices and thus employed technology. So Third world countries are poor since present institutions define a set of payoffs to economic activities that do not encourage productive activity.

Only in recent research, economists start to assert more and more the fundamental role for institutions as underlying determinant of economic performance. Hare(2001) gives high appeal for such a role in the analysis of economic performance in the transition countries. He emphasizes the importance of the establishing institutions needed for efficient functioning of market economy for successful transition. As argued by the author, institutional reform formed a key component of the policy package recommended to the Central and Eastern European and former Soviet Union countries, but it was not at the forefront of the reform programmes undertaken in the early transition. Macroeconomic stabilization, price and trade liberalization, privatization and enterprise restructuring formed the basic agenda for early reforms. It was erroneously thought that a market economy must be inherently more efficient than a centrally planned one. And it was taken for granted that opening markets would bring with it rather quickly and painlessly the needed institutions to make the new system work properly. The author says that now it is well understood that these arguments were fundamentally wrong, and active efforts to create and support new institutions are vital.

When discussing the role of institutions in transition economies, McMillan(1997) puts it very nicely: "a market is an institution, which needs rules and customs in order to operate. Given the uneven distribution of information among them [i.e.,

economic agents], the rules of exchange must be cleverly structured for a market to work smoothly. Institutions and organizations must evolve, to transmit information and to provide appropriate incentives".

Indeed, as in Campos and Coricelli (2002), institutions were part of the story when discussing different economic performance in transition in terms of such stylized facts as output decrease, lack of capital , labor reallocation, trade reorientation, and last, but not least, institutions collapse. Central planning was considered as an institutional arrangement, and transition to market on itself is a large-scale institutional change. Of course, investigation of this institutional change should have high priority in research of growth in transition. However, the difficulty is to find theoretically justified channels through which institutions affect economic performance. Though, some researches as Romer (2000) concluded their search with the concept of social infrastructure or social capital that incorporate cultural factors, religion, ethnic diversity, family structure, civic participation, underlying incentives and preferences. Another difficulty is in identifying theoretically sound measures of institutions relevant to economic performance of transition economies and in finding systematic panel data set instead of the incomplete and mostly cross-sectional indicators.

Empirical studies on the role of institutions

Now there are many investigations that illustrate the importance of institutions for economic performance across a much wider range of countries than the transition countries alone, seeking to explain why some of economies have good economic performance while others do not.

Kaufmann and Kraay (2002) investigate the high correlation between the quality of governance and per capita incomes across great number of developed and

developing countries among which transition countries are. Then paper confirms a common wisdom of significant positive impact of good institutions on economic performance.

Hall and Jones (1998) tackle the question of huge difference in output per worker across countries in the world. Standard neoclassical theory using aggregate production function explains such differences in terms of productivity, capital and labor return. The authors found that the difference in capital and human capital returns could account not much in explaining the dramatic difference in output per worker. As argued, the key is in the difference in the so called "social infrastructure" that is formed by institutional structure of the economy and has a direct effect on overall productivity of the economy.

Building reliable institutions that support a market system as proved by Brunetti et al. (1997) is a central precondition for successful economic transition. Their research suggest that differences in the "degree of predictability" of the institutional framework may indeed be an important factor in explaining differences in economic growth as well as differences in foreign direct investment across transitional economies.

In the spirit of North's institutional framework, all these cross-section empirical studies rely on path-dependence of institutions and economic performance, and "have drawn much comfort" from the assumption that institutions do not change, or they change so slowly that cross-sectional data enables to investigate thoroughly the link between institutions and economic performance, thus throwing away any significant implications of institutional change itself.

Of course, one can assume that institutions do not change much in the developed economies as if they found their optimum institutional framework. Such

assumption sounds not plausible for transition countries, as transition countries are still in "search" for this optimal institutional framework.

Transition countries try to find their institutional matrix that effectively solves problems of "social conflict management" (Rodrik, 1997), and what is now taking place in the former communist countries is a large scale institutional change. To have a chance to observe it, one should find empirical measures that reflect institutional evolution over time and across countries and to evaluate whether at least some have detectable effects on different dimensions of economic performance.

One important panel study for the effects of institutions on economic performance is discussed in Barro (1996), where three-period panel was used for investigating how different measures of 'democracy' affect economic growth. The problems of omitted factors and endogeneity of institutional measures were addressed

Another, important panel study for first mapping of institutional change during transition is done by Campos (1999). The five dynamic institutional dimensions of governance were constructed and assessed in their ability to differentiate development performance across transition countries over time. Dimensions of development performance were taken to be per capita income (levels and rates), school enrolment and life expectancy at birth. Most influential dimensions of institutional governance were quality of bureaucracy and the rule of law.

Perhaps, the most comprehensive study of the links between institutional change and economic performance in transition countries is done by Havrylyshyn and van Rooden(2000). This paper considers institutions as only a part of key determinants of economic performance and shows the importance of market-

enhancing institutions for restoring economic growth in transition. Still, macroeconomic stabilization and implementing economic reforms remain the most essential determinants of growth. In panel data framework, the authors proved that "institutions matter in transition, but so do policies".

As already mentioned, important advantage of panels in the research of the influence of institutions, is the ability to address the institutional change and crucial and often frequent shifts in political and economic regime.

In particular, this paper is focusing on the investigation of the link between economic development and institutional quality for transition countries during the last decade. Exploiting the advantage of panel framework, time-variant institutional measures will efficiently differentiate transition countries in terms of their institutional quality and institutional change. The importance of this institutional change for economic performance of particular country will be investigated.

Chapter 3

THEORETICAL FRAMEWORK FOR EMPIRICAL MODEL

This section elaborates on the theoretical framework for the incorporation of institutions into empirical analysis of economic performance.

3.1. Theoretical framework

The aim of introducing a theoretical model is to help to clarify the possible channels of influence on economic development of quality of institutions. Hereafter, under economic development we will consider one of its main dimension – the income per capita or GDP per capita. This will mean addressing to such fundamental economic issue as an economic growth.

First, we elaborate how institutions might be incorporated via Solow growth model. In the benchmark human capital-augmented Solow model, a production function has the following form (Mankiw, Romer and Weil ,1992)(MRW) :

$$Y(t) = K(t)^{\alpha} H(t)^{\beta} (A(t) L(t))^{1-\alpha-\beta}, \quad \alpha + \beta < 1 \qquad (3.1)$$

where

Y(t) – a value-added measure of output in reported economy at time t;

K(t) – physical capital at time t;

L(t) – labor force and

A(t) – the level of technology, which augments labor. This measure can be regarded as the way production is organized and the efficiency of using the factors of production.

Decreasing return to scale ($\alpha + \beta < 1$) production function is assumed. Labor force and technical progress are assumed to grow at the exogenous rates, n_i and g, from an initial country specific levels, L(0) and A(0) respectively.

Rewrite quantities in terms of effective unit of labor k = K/AL, h=H/AL and y=Y/AL. Assuming constant fractions of output invested into different types of factors of production (s_k – fraction for physical capital, s_h – fraction for human capital), MRW substitute the steady state expressions $\dot{k} = 0$ for these type of capital and get the following steady state expressions for output per worker:

$$\ln\left(\frac{Y(t)}{L(t)}\right) = \ln A(0) + gt - \frac{\alpha+\beta}{1-\alpha-\beta}\ln(n+g+d) + \frac{\alpha}{1-\alpha-\beta}\ln(s_k) + \frac{\beta}{1-\alpha-\beta}\ln(s_h) \tag{3.2}$$

where d – rate of capital depreciation.

An obvious question may arise here what the institutions have to do with this steady state income per capita? How to incorporate them into the equation (3.2) ?

In the literature the main role for institutions in the equation (3.2) is realized via A(0) – the initial level of technology, a broadly defined term. Actually, in this model A(0) incorporates 'permanent differences in the production functions' (MRW) and includes such factors as institutions, natural resource endowments,

technology, which are vary across countries. Intuitively, institutions provide the incentive structure of the economy; ensure efficient contract enforcement and efficiency of investment, which facilitate economic development. To ignore this variable in the empirical estimation of Solow model would mean to get classical omitted bias in the estimated coefficients. Indeed, as documented in recent research (e.g. Knight et al, 1993), panel data models which estimate the A(0)'s as fixed country effects, rather than assuming them away, get far more consistent estimates of rate of convergence and rate of investment return in the Solow labor-augmented model. Often, country specific dummies may be a proxy for the omitted A(0)'s, meanwhile, some additional variables may have significant effect on growth only because of their high correlation with omitted A(0)'s rather than having a direct causal role (this will be addressed in the empirical part of the paper).

Another potential role of institutions in the equation (3.2) is via g, the rate of technical progress, which was assumed to be exogenous and the same across countries. Relaxing this constraint in the Solow model is plausible, as one would expect the technological progress to differ across countries because of the difference in the fundamental institutions needed for setting new technology. The idea is that innovation in the technology depends heavily on social and institutional infrastructure (general education, development of business, technical competence, financial sector development). The institutions in place reduce the risks, provide the incentives and rewards for innovative economic activity.

We may conclude that institutions matter for economic development that was illustrated on the example of Solow augmented model. And ignoring the countries' specific factors, that explicitly include the measures of institutions, will yield inconsistent and biased results in the estimation of Solow model. What we are saying here is that institutions are among the most important factors in the

Solow model, but we do not say (and are unable to prove) that institutions capture all possible country specific effects, significant in the model (3.2) . This means that all included additional variables (including measures of institutions) are inadequate proxies for A(0), and this will eventually lead to omitted variable problem, and possible endogeneity.

Here, we may raise the question of the endogeneity of possible measures of institutions. Mainly, not only good institutions may have a positive impact on income per capita, but increased income per capita, thus wealthier society, has positive effect on the quality of institutions. That is, in a richer and more developed society there is high demand for better institutions. In case of transition countries, being in dynamic state of economic development and institutional change, this question has especially high appeal.

To solve this problem and to disentangle the link between institutions and income per capita, the structural system approach can be used.

3.2 Structural system approach

As already mentioned, to separate cause and effect between institutions and economic growth, one should take structural approach, which explicitly addresses the problem of omitting significant factors and consequent endogeneity. Relying on this framework, a structural system of two equations may be introduced as follows (Aron, 1998):

$$G = G (I, I_{-1}, Z) \quad (3.3)$$

$$I = I (I_{-1}, G, G_{-1}, X) \quad (3.4)$$

where

G – is measure of economic development – GDP per capita; I – possible measures of quality of institutions (discussed in detail in the data description section); Z - is the set of additional explanatory variables for economic growth such as initial GDP per capita, investment, and education. A more extensive set of X also includes fertility rate, government spending, black-market premium on foreign exchange, and change in terms of trade; X – is the set of variables, which can be regarded as the exogenous fundamental determinants of the quality of institutions. Index with -1 means lagged for one period of respective variable.

More specifically, the equations (3.3-4) may be written as follows (Kaufmann and Kraay,2002) :

$$y_{it} = \alpha + \beta i_{it} + e_{it} \quad (3.5)$$

$$i_{it} = \mu + \gamma y_{it} + \delta x_{it} + v_{it} \quad (3.6)$$

$$y_{it}^* = y_{it} + w_{it} \quad (3.7)$$

$$i_{it}^* = i_{it} + u_{it} \quad (3.8)$$

where

y_{it} – log income per capita in country i during period t;

i_{it} – measure of quality of institutions in country i during period t,

x_{it} – exogenous determinants of institutional quality.

y_{it}^* and i_{it}^* are observed income per capita and observed measure of institutional quality. Equations (3.7-3.7) state that we do not observe actual levels of income per capita and institutional quality, but with measurement errors w_{it} and u_{it}, respectively.

All disturbances in the four equations are combined, in the sense that they may consist of time-invariant and time-variant parts (e.g. $e_{it} = E_i + E_{it}$).

Disturbances e_{it} capture all possible factors (e.g. Z from (3.3)) that are outside of the very parsimonious model (3.5).

Equation (3.5)

The structural system (3.5-3.8) enables us to obtain consistent estimates of β and γ, which are the prime of our interest. Next part will elaborate on this estimation.

3.3 The model derivation

The structural model (3.5-3.8) needs assumptions on disturbances in order to be completely identified. In particular, we assume that the disturbances have zero mean and constant variances as in Kaufmann and Kraay (2002):

$$E(e_{it}) = E(v_{it}) = E(u_{it}) = E(w_{it})=0; \quad (3.9)$$

$$E(e_{it}^2) = \sigma_e^2, \quad E(v_{it}^2) = \sigma_v^2, \quad E(u_{it}^2) = \sigma_u^2, \quad E(w_{it}^2) = \sigma_w^2 \quad (3.10)$$

or, (3.10) can be written as,

$$E((e_i + e_{it})^2) = \sigma_e^2, \quad E((v_i + v_{it})^2) = \sigma_v^2;$$

$$E((u_i + u_{it})^2) = \sigma_u^2, \quad E((w_i + w_{it})^2) = \sigma_w^2,$$

Hereafter, in our cross-section time-series approach we assume e_{it} , v_{it}, u_{it}, w_{it} to denote composite disturbances (e.g. $e_{it} = e_i + e_{it}$).

In addition, we assume that measurement errors w_{it} and u_{it} are uncorrelated with disturbances e_{it} and v_{it}, and with exogenous determinants of institutions x_{it}.

$$E(w_{it}\, e_{it}) = E(w_{it}\, v_{it}) = E(w_{it}\, x_{it}) = 0; \quad (3.11)$$

$$E(u_{it}\, e_{it}) = E(u_{it}\, v_{it}) = E(u_{it}\, x_{it}) = 0; \quad (3.12)$$

Other assumptions on disturbances:

$$E(v_{it}\, x_{it}) = 0\ , \text{ but } \quad E(v_{it}\, e_{it}) = \rho\, \sigma_e\, \sigma_v \quad (3.13)$$

Assumptions (3.13) imply that omitted variables in the equation (3.6) are uncorrelated with x_{it} (orthogonality condition) and that, disturbances in the two structural equations (3.5) and (3.6) have correlation ρ. This imply the possibility of other variables, not included in the parsimonious model, that has an impact on both GDP per capita and quality of institutions.

Finally, we make the cross-orthogonality assumptions, that omitted variable in (3.5) are uncorrelated with x_{it}:

$$E(e_{it}\, x_{it}) = 0 \quad (3.14)$$

Assumptions (3.14) enables us to use x_{it} as the instrument for institutional quality i_{it} in the equation (3.5) and obtain consistent estimate of β.

The same logic can be applied to estimate the equation (3.6) if suitable instruments for income are found. In practice, it is very difficult to do as it is hard to find convincing instruments for income. Instruments for income in (3.5) should correlate with income and have no impact on institutional quality other than through effect on income. Many determinants of income differences, such as natural resource endowment, climate, colonial history have direct effect on

institutional quality as well. Thus we are unable to use them to instrument income in the equation (3.6).

As the search for convincing instruments for income does not provide good strategy, some other outside information should be incorporated.

We follow Kaufmann and Kraay (2002) method to use non-sample information to identify the structural model (3.5) – (3.8).

Firstly, the reduced forms of the equations (3.5) – (3.8) are expressed as:

$$i_{it}^{*} = \frac{\mu + \gamma\alpha}{1 - \gamma\beta} + \frac{\delta}{1 - \gamma\beta} x_{it} + \frac{\gamma e_{it} + v_{it}}{1 - \gamma\beta} + u_{it} \qquad (3.15)$$

or, it terms of observed data and estimated coefficient:

$$i_{it}^{*} = \hat{\pi}_0 + \hat{\pi}_1 x_{it} + \hat{\sigma}_2^2 \qquad (3.16)$$

where $\hat{\pi}_0 = \frac{\mu + \gamma\alpha}{1 - \gamma\beta}$, $\hat{\pi}_1 = \frac{\delta}{1 - \gamma\beta}$ (3.17)

$$\hat{\sigma}_2^2 = \text{var}\left(\frac{\gamma e_{it} + v_{it}}{1 - \gamma\beta} + u_{it} \right) \qquad (3.18)$$

Second reduced form apart from the first (3.15) is as follows:

$$y_{it}^{*} = \frac{\alpha + \beta\mu}{1 - \gamma\beta} + \frac{\beta\delta}{1 - \gamma\beta} x_{it} + \frac{e_{it} + \beta v_{it}}{1 - \gamma\beta} + w_{it} \qquad (3.19)$$

Rewriting equation (3.5) in terms of observables:

$$y_{it}^{*} = \alpha + \beta\, i_{it}^{*} + e_{it} - \beta\, u_{it} + w_{it} \qquad (3.20)$$

In equations (3.15) through (3.20) we assume that the stability condition $1 - \gamma\beta > 0$ holds. This implies an upper bound restriction on interested coefficient $\gamma < 1/\beta$.

The structural system (3.5-3.8) has ten unknown parameters which need to be found. They are $\alpha,\ \beta, \mu, \gamma, \delta, \rho, \sigma_e^2, \sigma_v^2, \sigma_w^2$ and σ_u^2.

On the other hand, in terms of observed data and through reduced form equations (3.15) and (3.20), we have seven independent pieces of sample information. In particular, these are estimated intercept, slope and variance of the first-stage reduced form regression (3.16) - $\hat{\pi}_0$, $\hat{\pi}_1$ and $\hat{\sigma}_2^2$. These are also estimated intercept, slope and variance of the second-stage regression equation (3.20) - $\hat{\alpha},\ \hat{\beta}$ and var $(e_{it} - \beta u_{it} + w_{it})$. Estimates $\hat{\alpha},\ \hat{\beta}$ are believed to be consistent two-stage least squares estimates.

Finally, the seventh piece of independent sample information we can obtain through running OLS regression of per capita income on institutional quality, thus obtaining estimated OLS slope coefficient $\hat{\beta}_{OLS}$. This information will be used in the additional identification constraint in terms of our ten unknown parameters.

The only way to fully identify structural system (3.5-3.8), is to assume some feasible values of σ_w^2 (variance of measurement error in log income per

capita) and σ_u^2 (variance of measurement error in institutional quality). Note that data will allow us to impose plausible values of both variances.

The correlation ρ between errors terms in equation (3.5) and (3.6).

Thus, by imposing three additional constraints on σ_w^2, σ_u^2 and ρ, the remaining seven parameters can be found using seven independent pieces of sample information.

From equation (3.20), the estimated variance of residuals should equal var $(e_{it} - \beta u_{it} + w_{it})$, which gives us the estimate of σ_e^2. Then we solve three equations for three unknowns γ, δ, σ_v^2:

$$\hat{\pi}_1 = \frac{\delta}{1 - \gamma\beta}; \tag{3.21}$$

$$\hat{\sigma}_2^2 = \frac{\gamma^2 \cdot \sigma_e^2 + 2 \cdot \gamma \cdot \rho \cdot \sigma_e \cdot \sigma_v + \sigma_v^2}{(1 - \gamma\beta)^2} + \sigma_u^2 \tag{3.22}$$

$$\hat{\beta}_{OLS} = \frac{\delta^2 \cdot \beta \cdot \sigma_x^2 + \gamma \cdot \sigma_e^2 + \beta \cdot \sigma_v^2 + (1 + \gamma \cdot \beta) \cdot \rho \cdot \sigma_e \cdot \sigma_v}{\delta^2 \cdot \sigma_x^2 + \gamma^2 \cdot \sigma_e^2 + \sigma_v^2 + 2 \cdot \gamma \cdot \rho \cdot \sigma_e \cdot \sigma_v + (1 - \gamma \cdot \beta)^2 \cdot \sigma_u^2} \tag{3.23}$$

where σ_x^2 is the variance of the exogenous determinant x_{it} of institutional quality.

The equation (3.21) is directly from (3.17). The equation (3.22) expresses the estimated variance of the residuals in the first-stage regression (3.15), while last equation (3.23) is just the additional identification constraint on our parameters.

Using the fact that $\hat{\beta}_{OLS} = \frac{\text{cov}\,(y_{it}, i_{it})}{\text{var}(i_{it})}$ in OLS regression of y_{it} on i_{it}, and the reduced forms (3.15) and (3.19).

Finally, we obtain consistent estimate of μ from the estimated intercept in the first-stage regression (3.16) :

$$\hat{\pi}_0 = \frac{\mu + \gamma\alpha}{1 - \gamma\beta}$$

Hence, by incorporating three pieces of non-sample information, we obtain a fully identified system of equations, and are able to find all parameters of the structural system (3.5-3.8). The focus of our interest is in the feedback effect of income on institutional quality, i.e., in the estimate of γ.

C h a p t e r 4

EMPIRICAL ANALYSIS

4.1 Data description

The data we use in the empirical estimation is unbalanced panel data for 26 transition countries: 11 countries of Central and Eastern Europe (Albania, Bosnia-Herzegovina, Bulgaria, Croatia, Czech Republic, Macedonia, Hungary, Poland, Romania, Slovak Republic, Slovenia), 3 Baltic countries (Latvia, Lithuania, Estonia) and 12 countries of the former Soviet Union (Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyz Republic, Moldova, Russia, Tajikistan, Turkmenistan, Ukraine, Uzbekistan) in 1989-2002 period of time. Firstly, we concentrate on the description of our main variables – measures for quality of institutions.

Data on measures of institutional quality

The measurement of the quality of institutions is a challenging problem itself. The institutions that matter for economic development are very complex and any single measure most likely will capture only a part of the formal and informal rules and constraints that shape an economy's incentive structure.

Another essential feature in measuring the quality of institutions is the lack of objective data. Using the results of polls and surveys, in which the questions are a priory formulated to capture the normative range between a bad and a good outcome, we get subjective data. But it should be stressed that subjective data has significant advantages over objective. Subjective measures, reflecting human perceptions, may be as important as objective ones. In the case when a country

may have a set of good institutions according to certain objective standards, people may have doubts in that and feel misgovernance on the micro level. For example, two hypothesized countries may have similar anticorruption laws and regulations, while the level of corruption may vary significantly for them. Moreover, some objective measures can mislead the derivation of conclusions. For instance, it is unclear, whether a high number of criminals per capita in jails means a high or low level of rule of law.

In our empirical part to quantify the institutions and capture this complex web of interactions, we use three different data sets of subjective measures of institutional quality in the transition countries.

4.1.1 ICRG indices

Data comes from International Country Risk Guide (ICRG), the PRS Group. The risk rating system assigns a numerical value (risk points) to predetermined risk components according to a preset weighted scale for each country. Each scale is designed so that the highest value means the lowest risk, and the lowest value – the highest risk. ICRG constructs three aggregate risk indices: political, economic and financial. We focus on the components of political risk as it provides the means of assessing institutions and political stability of the country under the question. If to take into consideration that the measurement of political risk was conducted on the comparable basis regarding overall current political stability that has underlining determinants – institutions, we can consider composite risk index as a good representation of current quality of institutions.

To ensure consistency, both between countries and over time, points are assigned on the basis of a series of questions that depends on the type of

governance applicable to a particular country. A distinction is made between the following types of governance: alternating democracy, dominated democracy, de-facto one-party state, de-jure one-party state and autarchy. These classifications are fundamental to the rating process as the assessments of political institutions and risk in all components are based on the premise that the more democratic the society is, the more accountable it is; and the more accountable it is, the less susceptible it is to sudden political changes.

For a empirical estimation we use a composite political safety index **ICRG** that computed as the sum of all the rating political factors, which described below with their possible range in brackets [ ]:

Government Stability: the government's ability to carry out its declared programs, and its ability to stay in office. [0,12]

Internal Conflict: political violence in the country and its actual or potential impact on governance. [0,12]

External Conflict: assessment both of the risk to the incumbent government from foreign action, ranging from non-violent external pressure (diplomatic pressures, withholding of aid, trade restrictions, territorial disputes, sanctions, etc) to violent external pressure (cross-border conflicts).[0,12]

Corruption: assessment of corruption within the political system. [0,6]

Military in politics: protection from the military involvement in politics. [0,6]

Religious tensions: protection from the religious tensions in society. [0,6]

Law and Order: the Law sub-component is an assessment of the strength and impartiality of the legal system; the Order sub-component is an assessment of popular observance of the law. [0,6]

Ethnic Tensions: assessment of the degree of tension within a country attributable to racial, nationality, or language divisions. [0,6]

Democratic Accountability: 6 is assigned to Alternating Democracies, while 0 is assigned to autarchies.

Quality of Bureaucracy: institutional strength and quality of the bureaucracy is another shock absorber that tends to minimize revisions of policy when governments change. [0,4]

Thus, index **ICRG** has possible range of values from 0 to 76, with the highest score meaning the lowest risk. This index is available for 1998-2001 period annually, while for some CEE countries it is observed since 1989 year.

4.1.2 Campos' data set (1989-1996)

Four characteristics of good governance have been identified for 25 transition countries during 1989-1996 period by (Campos, 1999). All indices take value on the scale from 0 to 10, with higher value reflecting better institutional quality. It should be mentioned that during construction of these four indices the ICRG data also was used. Taking several more sources of data, the author constructs more informative indicators as follows:

CivicSociety – three indicators were merged to identify necessary conditions for strong civil society. The first two indicators are from Gastil (now Freedom House), civil liberties and political rights. The third is the "civil society" indicator from Karatnycky, Motyl and Shor (1998). The latter captures the degree to which volunteerism, trade unionism, and professional associations exist, and whether civic organizations are influential.

BureaQual - the quality of the bureaucracy - was constructed on the basis of two existing indicators. The first, available from the International Country Risk Guide (ICRG), is called "bureaucratic quality" and captures the extent to which the national bureaucracy enjoys autonomy from political pressure, has the

strength and expertise to govern in a stable manner without drastic changes in policy, and has an effective mechanism for recruiting and training. The second indicator from Holmes, Johnson and Kirkpatrick (1997, 1998) (Heritage Foundation) is "factor #9, regulation" that measures, on a 1-5 scale, the extent of licensing requirements to operate a business, the ease to obtain a business license and the corruption within the bureaucracy.

RuleLaw - was constructed on the basis of three indicators, the first two focusing on enforcement and the latter on the type and substance of the "law" itself. The first is again an ICRG indicator ("rule of law") reflecting the country-specific degree to which citizens are willing to accept the established institutions for making and implementing laws and adjudicating disputes. The second such indicator, from Holmes, Johnson and Kirkpatrick (1997, 1998) is their "factor #8, property rights." It measures, on a 1-5 scale, the government influence over the judicial system, the commercial code defining contracts, the sanctioning of foreign arbitration of contract disputes, corruption within the judiciary, delays in judicial decisions, and the extent of legally granted and protected private property. The third indicator upon which this measure is based is "rule of law" from Karatnycky, Motyl and Shor (1998). It measures on a 1 to 7 scale whether a post-communist constitution has been adopted, whether it does provide for property and human rights, whether the criminal code has been subject to reform, whether judges rule fairly and impartially and whether they were appointed during the communist era, whether the courts are free of political control, whether the state provide public defenders, and whether ethnic minority rights are protected.

TransAcc - two characteristics were merged ("accountability and transparency") and the following four series were used to construct the relevant indicator. From Karatnycky, Motyl and Shor (1998), "political process" and

"independent media" were used. The former reflects, on a 1 to 7 scale, elections, referenda, party configuration, conditions for political competition, and popular participation in elections. Using the same scale, "independent media" assesses the freedom of the press, public access to various information sources, and the independence of those sources from undue government or other influences. The other two indicators (from ICRG) capture the risk of government repudiation of contracts and the risk of expropriation, respectively.

4.1. 3 Kaufmann's governance clusters

Since 1996, the World Bank economists Kaufmann, Kraay and Mastruzzi (2003) conduct the project of the construction of comparable measures of various dimensions of institutions (governance) across countries around the world. Authors construct six aggregate governance indicators every two years (in 1996,1998,2000 and 2002). The classification criteria for these clusters were derived from definition of governance as the institutions and traditions by which authority is exercised in the particular country. Different indicators of the quality of the institutions (governance) were grouped into six clusters according to the following three basic principles:

- the process by which governments are selected, monitored and replaced;
- the ability of the government to formulate effectively and implement sound policies
- the respect of citizens and the state for the institutions that govern economic and social interaction among them.

The first two clusters "Voice and Accountability" and "Political Stability" reflect the first principle, next two "Government Effectiveness" and "Regulatory quality" capture the second principle and the last two clusters "Rule of Law"

and "Control of Corruption" correspond to the third principle, mainly, the respect for institutions.[1]

For the construction of governance clusters different sources were taken. These sources compromise international organizations, think-tanks, political and business risk-rating agencies, non-governmental organizations (NGO). According to the method of collecting information, produced ratings can be classified as polls of experts or as surveys of citizens and businesspeople in general.

For the transition countries, the following 16 sources (publications) were used:

- Business Environment Risk Intelligence (Quantitave Risk Measure in Foreign Lending)
- University Columbia (State Capacity Project)
- Economist intelligence Unit (Country Risk Service)
- EBRD (Transition Report)
- Freedom House (Nations in Transit)
- Freedom House (Freedom in the World)
- Heritage foundation (Economic Freedom Index)
- Amnesty International (Human Rights Report)
- Political Risk Services (ICRG)
- Reporters Without Borders (Press Freedom Index)
- Standard and Poor's (Country Risk Review)
- WB (Country Policy and Institutional Assessment)
- World Markets Online (World Markets Country Analysis)

which are the polls of experts, and the following 3 surveys:

[1] For a detailed description of six governance clusters see Appendix 1.

- WB (Business Enterprise Environment Survey)
- WB (World business Environment Survey)
- World Economic Forum (Global Competitiveness Survey).

To give an illustrative example of content of these sources, in the Global Competitiveness Survey by World Economic Forum, the following questions were ranked on a 1 to 7 scale (1 – absolutely false, 7 – absolutely true) across countries and incorporated into governance clusters:

"Voice and Accountability":

- Can newspapers publish stories of their choosing without fear of censorship or retaliation?
- Are firms usually informed clearly and transparently by the government on changes in policies affecting their industry?

"Political stability":

- Does the highest power always peacefully transferred?
- Does the new government honor commitments of previous governments?

"Government Effectiveness":

- Is it take time for senior management to deal with government officials;
- Are government economic policies independent of pressure from special interest groups?

"Regulatory quality":

- Are administrative regulations and tax system are burdensome?
- Do government subsidies keep uncompetitive industries alive artificially?

"Rule of Law"

- Is protection of financial assets and intellectual property is weak?
- Is judiciary dependent from political influences of government, citizens or firms?

"Control of Corruption"

- Is diversion of public funds due to corruption frequent?
- Do firms make frequent extra payments connected to public utilities, tax payments, loan applications, getting favourable judicial decisions?

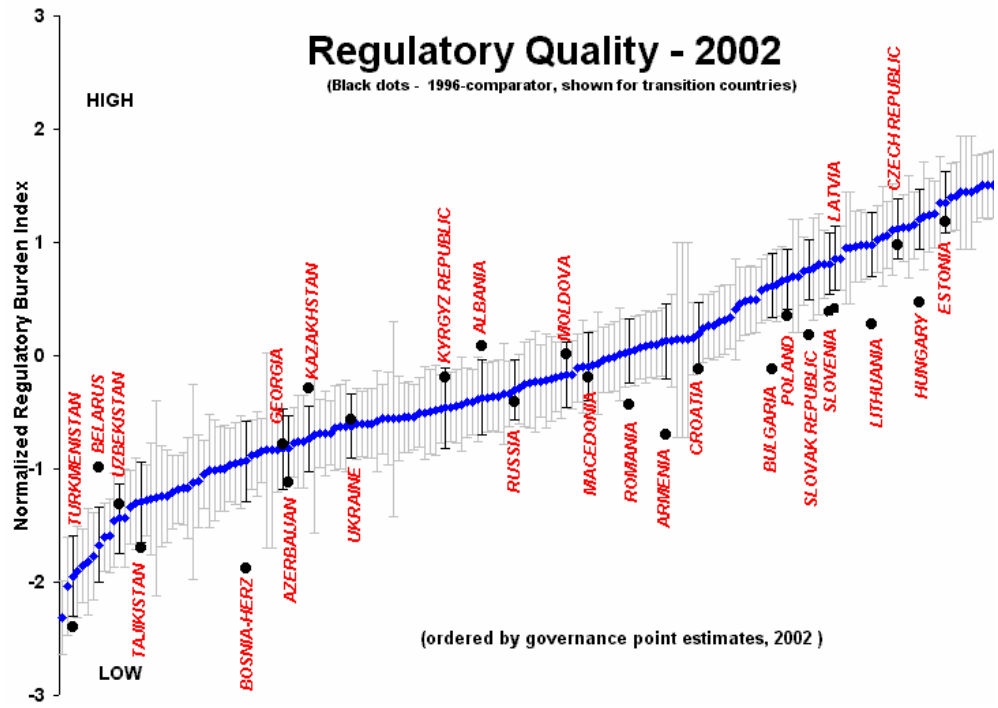
These questions represent only part of the whole list of the question which were later ranked and grouped into the six governance clusters. The use of one cluster that incorporates many indicators of similar underlying concept of governance provides more precise measure of governance than any individual indicator.

This clustering or aggregation of many similar in nature indicators into one gives opportunity to measure not only the needed estimate of particular dimension of institutions but to compute the precision of this estimate. This can be done by the use of aggregation methodology and standard unobserved components model, firstly used in (Kaufmann et al. 1999a).

As a result of aggregation methodology, we have six governance clusters estimates that are normally distributed with a mean zero and a standard deviation of one in each period. This implies that 99% of governance estimates range from –2.5 to 2.5. For some countries, a country rating might exceed these thresholds meaning that the country has an extremely poor institutional performance (below –2.5) or extremely good performance (above 2.5) in that specific dimension of governance.

In Figure 1, the "Regulatory Quality" cluster in 2002 year is shown with its estimates and margins of errors (standard errors) for 26 transition countries.[2] Black dots represent comparator estimates of the same cluster in 1996 year.

Figure 1. Estimates of " Regulatory Quality" cluster in 2002 year.



Source: World Bank Governance Indicators for 1996-2002, constructed by (Kaufmann, Kraay and Mastruzzi, 2003).

Measure of economic performance

By choosing the appropriate measure of economic performance of the transition country, one can consider among variety of such variables: income per capita, second school enrolment (male and female), life expectancy at birth

[2] Figures for other five governance clusters see in Appendix 2.

etc. In our empirical estimation we use the income per capita, taken so as to represent the most vital factor of economic performance.

Income per capita - taken as a log of GDP per capita at PPP basis from World Development Indicators (2003). PPP GDP is gross domestic product converted to international dollars using purchasing power parity rates. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in current international dollars.

Data used for construction of instrumental variables

To construct instruments for institutional quality we use variables that effectively differentiate transition countries:

Distance - the distance from capital city of each country to the Dusseldorf. This variable captures the concept of the proximity to the Western Europe. Data is from (Fisher and Sahay, 2000).

Years under communism - number of years the communist regime officially was in power in the particular country.

Years since transition -number of years since transition year which is defined as the year in which communist regime collapsed and "the country began to move towards the market economy". Data is borrowed from (Fisher and Sahay, 2000).

Summary statistics of all variables are given in the Table 1.

Table 1. Summary statistics of used variables (total sample)

Variable	# of obs	Mean	Std. Dev.	Min	Max
Income per capita	335	8.39	.74	6.47	9.78
Campos' set:					
CivicSociety	225	4.20	3.18	0.00	10.00
BureaQual	225	2.32	1.61	0.83	8.33
RuleLaw	225	5.66	2.49	2.00	10.00
TransAcc	225	6.71	1.75	3.00	9.50
Kaufmann's set:					
Av	104	-0.10	0.84	-1.85	1.17
Polstab	104	0.05	0.77	-2.84	1.27
Goveffic	103	-0.31	0.66	-1.47	1.02
Regqua	104	-0.28	0.94	-2.65	1.35
Rulelaw		-0.31	0.66	-1.42	1.09
Contcorr	103	-0.38	0.62	-1.53	1.08
ICRG	112	65.07	7.90	47.75	82.17
distance	364	2197.81	1479.18	559.00	5234.00
years_commun	300	57.19	14.62	41.00	75.00
trans_year	297	6.23	3.32	1.00	13.00

Note: *Income per capita* – log of GDP per capita, PPP; *CivicSociety* – index for strength of civil society; *BureQual* – the quality of the bureaucracy; *RuleLaw* – "law and order"; *TransAcc* – "transparency and accountability"; *Av* – "voice and accountability"; *Polstab* – "political stability"; *Goveffic* – "government effectiveness"; *Regqua* – **"**regulatory quality"; *Rulelaw* – "rule of law"; *Contcorr* – "control of corruption"; *ICRG* – composite index of ICRG; *distance* – distance to Dusseldorf from capital cities of transition countries; *years_commun* – number of years under communism; *trans_year* – number of years sincetransition.

4.2 Econometric analysis of link between income and institutional quality

This section provides the results of empirical estimation of economic impact of institutional quality on incomes in the transition economies. The feedback influence of income on institutional quality is also investigated by the use of non-sample information method.

Constructing the instruments for institutional measures

To evaluate the influence of institutions on income, we start the estimation of the first structural equation (3.5)

$$y_{it} = \alpha + \beta\, i_{it} + e_{it}$$

Obviously, to obtain consistent estimates of α and β, the orthogonality condition , i.e. $\text{corr}(i_{it}, e_{it}) = 0$, should hold. This is hardly believable as disturbances e_{it} include all possible factors that have direct impact on income per capita and that are outside of this very parsimonious model. Even after exploiting fixed-effect technique for panel regression analysis of the equation (3.5), which distill the effect of time-constant country specific factors, time-variant factors of income will remain in disturbances e_{it} (consumption, investment, inflation, trade etc) . These factors most likely have direct effect on income y_{it} rather than indirect only through institutions. Such possibility disqualifies all consequent estimations of (3.5) by panel data techniques as biased and inconsistent estimates will result.

To overcome this problem instruments for institutional quality should be incorporated into analysis. The requirements for convincing instruments are to be uncorrelated with omitted variables, i.e. error terms e_{it} , and be highly correlated with institutional quality measures.

Thinking about such instruments for institutions in the transition countries, one should find some common feature for these countries which may efficiently differentiate among them in terms of levels of political, social and economic infrastructure development.

In recent literature, the historical factors are highly motivated and empirically proved to be good instruments for institutional level across countries (Acemolgu et al. 2001, Hall and Jones, 1999). For transition countries, one common historical feature is that they were several decades under communist regime. Transition countries were different periods of time under communism and they also differ in the year of gaining independence and starting transition from planned to market-oriented economy. These historical facts can be used in constructing convincing instruments for institutional quality in post-communist countries. The intuition behind it is that country with smaller period under communism has a better "market memory", which was established previously through the capitalistic system in West and in some regions of Central and East Europe. A country with better "market memory" should establish more rapidly the proper institutions for market-structure economy after the beginning of transition.

The problem of using these historical instruments for the institutions is that all of them were applied as a time-constant initial condition factors in the cross-sectional analysis. And time-constant variables can not be used as an instruments for institutional measures in fixed-effects estimation (which would be employed

latter to find consistent estimates), where all time-constant country-specific factors are purged out. To solve this problem we should make these instruments to be time-variant. The idea of constructing time-variant instrument for institutions for *i* transition country can be implemented as follows:

$$Instr\_commun_{it} = (years\ in\ transition_t\ at\ time\ t / years\ under\ communism_i).$$

Thus, for the country with a small number of years under communism, this instrument will increase in every year by a constant rate which would be much higher than those for the country with a large number of years under communism.

This instrument is assumed to be good in terms of its low correlation with omitted economic time-variant factors of income in the equation (3.5). As institutional quality is a broadly defined term, all possible determinants of income that have something to do with history, will most likely have only an indirect effect through institutional quality variable.

In terms of instrument's correlation with different measures of institutional quality, it performs well. This can be explained by the fact that on average institutional quality for transition states is increasing over time from the beginning of transition (though, there are countries with decreased institutional quality). From the other hand, this is, of course, a possible drawback of instrument as it is only increasing and can hardly capture the decrease in institutional quality over time. But emphasizing the fact that institutions do improve over time on average and the need to differentiate among countries how fast they improve, the $Instr\_commun_{it}$ provide a good mapping of the development process of institutions over time on the post-communist region .

The correlation of $Instr\_commun_{it}$ with three set of institutional measures (described in data description section) is as follows:

For Campos (1999) set of indices:

	CivilSociety	*BureaQual*	*RuleLaw*	*TranAcc*
Corr =	*0.7011*	*0.5343*	*0.6339*	*0.5450*

For ICRG composite political index::

	ICRG
Corr =	*0.5115*

For Kaufmann's 6 clusters:

	av	*polstab*	*goveffic*	*regqua*	*rulelaw*	*contcorr*
Corr =	*0.6516*	*0.4076*	*0.5740*	*0.5945*	*0.6175*	*0.5775*

The evident fact is that East and Central European countries have better institutional quality than Former Soviet Union (FSU) countries, and this can be explained it terms of their proximity to West Europe. Allowing this information to enter into instrumental variables construction will provide more efficient differentiation of transition countries, and thus higher correlation with them.

The distance from capital cities to West Europe (city Dusseldorf) will capture this difference among CCE and FSU countries. If to let this variable to enter as independent instrument, this will disqualify its using in the fixed-effects panel estimation. As in previous paragraph, distance is considered to be exogenous and uncorrelated (at least, low correlated) with omitted factors in (3.5), namely e_{it}.

To incorporate relevant information on distances into time-variant instrument, we construct new instrument as follows:

$$New\_instr_{it} := (Instr\_commun_{it} * 10000) / distance_i$$

Thus, the nearer country to West Europe the higher increase from year to year is expected in its institutional quality measure.

We review correlation of New_instr_{it} with 3 sets of institutional quality measure as in previous paragraphs:

For Campos (1999) set of indices:

	CivilSociety	*BureaQual*	*RuleLaw*	*TranAcc*
Corr =	*0.7228*	*0.6631*	*0.6638*	*0.6246*

For ICRG composite political index::

	ICRG
Corr =	*0.6437*

For Kaufmann's 6 clusters:

	av	*polstab*	*goveffic*	*regqua*	*rulelaw*	*contcorr*
Corr =	*0.7464*	*0.5807*	*0.7402*	*0.6546*	*0.7587*	*0.7509*

As can be seen, correlation of new instrument with institutional measures is increased significantly, in some cases almost by 30%.

The construction of single instrument for institutions constrains us to include at most one measure of institutional quality. This is not very implausible if to consider high correlation among different measures of institutions and possible multicollinearity problem after including several of them in to the one regression

equation. In all cases, we can always construct single measure as a simple average over indicators in the particular data set.

Estimation of institutions' influence on income

Now we can proceed with estimation of the equation (3.5) using our constructed instruments for institutional measures in transition countries and using panel regression techniques.

$$y_{it} = \alpha + \beta\, i_{it} + e_{it}\ , \qquad (3.5)$$

where y_{it} - log of income per capita, i_{it} – institutional quality measure.

It should be mentioned that our measures of institutional quality are highly correlated among each other and this suggests that they move together and sometimes capture the overlapping dimensions of institutions. This fact suggests multicollinearity problem in the model specification when one includes all variables. Thus, firstly we investigate the individual effect of each measure as a broad notion of institutional quality and only later consider consolidated institutional measure within each data set.

After estimating the equation (3.5) using pooled OLS, we get consistent estimates only in the case of insignificant country specific factors. F-test rejects the hypothesis of the common intercept for almost all indicators, except for two Kaufmann's clusters "Political stability" and "Control of Corruption", for which pooled regression estimation is more appropriate (see Table 2). This finding can suggest that the omitted time-constant variables are uncorrelated with "Political stability" and "Control of Corruption" and affect income only through these governance clusters. We still need to instrument our institutional measures in the

pooled regression estimation as it can not be assumed about no correlation between time-variant omitted variables and our institutional measures.

Table 2. Estimates of influence of institutional quality on income per capita in the equation (3.5)

	Institutional measure	OLS (IV pooled)	IV estimates (FE)	First-stage(FE)
	ICRG	**0.08** (0.000)	**0.11** (0.034)	**1.54** (0.029)
Campos set	*CivicSociety*	**0.27** (0.000)	**0.09** (0.011)	**1.09** (0.000)
	BureaQual	**0.41** (0.000)	**0.15** (0.011)	**0.63** (0.000)
	RuleLaw	**0.30** (0.000)	**0.06** (0.009)	**1.63** (0.000)
	TranAcc	**0.40** (0.000)	**0.09** (0.005)	**1.07** (0.000)
	"Campos consolidated"	**0.33** (0.000)	**0.08** (0.006)	**1.11** (0.000)
Kaufmann's set	*"Voice and Accountability"*	**0.97** (0.000)	**1.24** (0.000)	**0.20** (0.000)
	"Political stability"	**1.36** (0.000)	**26.97** (0.922)	**0.01** (0.922)
	"Government Effectiveness"	**1.24** (0.000)	**1.68** (0.008)	**0.14** (0.007)
	"Regulatory quality"	**0.99** (0.000)	**1.07** (0.005)	**0.23** (0.006)
	"Rule of Law"	**1.21** (0.000)	**2.11** 0.014	**0.11** (0.009)
	"Control of Corruption"	**1.30** (0.000)	**6.02** (0.481)	**0.04** (0.486)
	"Kaufmann's consolidated"	**1.09** (0.000)	**1.41** (0.000)	**0.17** (0.000)

Note: In parentheses the significance levels of estimates are provided. CivicSociety – index for strength of civil society; BureQual – the quality of the bureaucracy; RuleLaw – "law and order"; TransAcc – "transparency and accountability". "Kaufmann's composite" -average of all Kaufmann's governance clusters except for "political stability" and "control of corruption". R^2 ranges from 53% to 62% in all regressions.

Estimated coefficient 1.*36* in the two-stage least squares pooled regression for "Political stability" suggests that an increase in level of political stability by one unit leads to 289% increase in the level of income per capita, or what is the same, as income per capita is expected to rise by 3.89 times(exp(1.36)= 3.896193). This sounds plausible if to consider one unit increase in "Political stability" is an

immense improvement in institutional quality. This increase will move such country as Georgia to the level of political stability of Hungary in the year 2000.

For all institutional measures, others than "Political stability" and "Control of Corruption", the consistent coefficients will be obtained only through fixed-effects panel instrumented regression. Random-effects technique is not applicable here, as one of the fundamental assumptions for random-effect method to give consistent estimates is a strict exogeneity condition, i.e. institutional measures are uncorrelated with all omitted variables (Wooldridge, 2002). This condition is hardly plausible in our very parsimonious model (3.5), as almost all important variables, except institutional quality variable, are omitted. Thus, GLS (RE) is not appropriate. To make some sense it can be mentioned that the usefulness of applying panel data is to allow a correlation of explanatory variables with omitted factors, thus addressing the problem of cross-country heterogeneity.

For consolidated *Kaufmann's* cluster (average of all Kaufmann's governance clusters except for "Political stability" and "Control of corruption"), we get *1.41* - an estimated coefficient in the equation (3.5) by using our instrument in fixed-effects 2SLS. This suggests that one deviation (one unit) increase in average Kaufmann's governance cluster should promote an increase in incomes by almost 4 times (exp(1.41)≈ 4).

For *ICRG* index, we have the influence of magnitude *0.11* for each 1 point increase in ICRG index. This is quite strong influence and reasonable comparing with other two data sets, if to take into consideration that ICRG index ranges from 0 to 76. One standard deviation increase, that equals *7.89*, results in an increase in incomes by *2,38* times (exp(7.89*0.11) ≈ 2.38). This impact is obviously smaller than for consolidated Kaufmann's cluster suggesting that ICRG index captures slightly different institutions.

For *Campos'* institutional measures all coefficients are significant and have expected positive signs. Estimates are statistically significant under both pooled and fixed-effects estimation, while consistent and unbiased estimates are obtained only in latter (as omitted variables have direct influence on income as well). For consolidated *Campos'* measure (average of "civil society", "bureaucracy quality", "rule of law" and "transparency and accountability"), we get the coefficient *0.08*. Then, for one deviation increase (*1.95)* in this variable, income will rise by 17% ($\exp(1.95*0.08) \approx 1.17$).

Interpreting such different magnitudes of institutional quality's influence on income, one should take into consideration the scale of measurement of each consolidated index and possible different captured dimensions of "institutional matrix". For consistency and comparability of the results across countries and over time, it is better to make conclusions and policy implications within each data set.

In general the results for transition countries are consistent with common wisdom and different dimensions of institutional quality have statistically significant positive impact on economic performance, namely, on income per capita.

Estimation of the feedback influence of income on institutional quality

More controversial is the feedback influence of incomes on quality of institutions. One can think that richer societies should demand higher quality of institutions to be in place. Moreover, there should be direct incentives from increased incomes to improve institutions. If this direct link is deterred, then we will not experience better institutions. To investigate this side of actual high correlation between income per capita and institutional quality, we should proceed with model derived in previous sections.

In the core of estimation is the equation (3.6):

$$i_{it} = \mu + \gamma y_{it} + \delta x_{it} + v_{it} \qquad (3.6)$$

where we are interested in true estimate of γ - impact of income on institutional quality .

To explore the derived model (3.21-3.23), we will use Kaufmann's governance clusters, as only for them we have data on the precision of institutional estimates (non-sample information).

As was mentioned in theoretical part, we should use such complicated method to estimate the coefficient γ, as it is practically impossible to find convincing instrument for income that would not have direct effect on institutions.

In order to fully identify the simultaneous system (3.5-3.8), we have to impose some values for three additional parameters, mainly σ_u (standard deviation of measurement error in institutional quality), σ_w (standard deviation of

measurement error in income per capita) and ρ (correlation between omitted variables in the equations (3.5) and (3.6)).

The measurement error in log of income per capita we assume to be $\sigma_w := 0.2$ (taken as a 5% of standard deviation in log of income per capita) . This margin of error is plausible if to consider little difficulties in measuring GDP and purchasing power parity adjustments. Moreover, our identification is not sensitive to variance of measurement error in income per capita.

We need also to impose some values on σ_u and ρ. For consolidated Kaufmann's indicator we impose $\sigma_u = 0.2$, which is an average value of margin of errors for all included governance clusters for transition countries. The correlation ρ is allowed to vary in feasible range [-1,1].

In solving numerically the system (3.21-3.23) for γ, δ, σ_v , we get values for these three parameters while varying the value of ρ[3]. Results are presented in the Table 3.

[3] Program in Maple 9.0 for numerical solving the system (3.21-3.23) see in the Appendix 4.

Table 3. Estimates of γ, δ, σ_v from equations (3.21-3.23).
For ***consolidated Kaufmann's governance cluster***

Fixed: $\sigma_w = 0.2$ & $\sigma_u = 0.2$

ρ =	-0.55	-0.5	-0.4	-0.3	-0.2	-0.1	0	0.1
γ	**0.018**	-0.054	-0.22	-0.44	-0.76	-1.26	-2.25	-5.22
δ	0.16	0.18	0.22	0.27	0.35	0.46	0.70	1.39
σ_v	0.61	0.65	0.74	0.88	1.10	1.45	2.17	4.36

Fixed: $\sigma_w = 0.2$ & $\rho = 0$

	min	avg							max
σ_u =	0.12	0.20	0.3	0.42	0.43	0.45	0.478	0.5	0.74
γ	-2.65	-2.25	-1.47	-0.12	**0.02**	0.29	0.70	1.04	5.69
δ	0.79	0.70	0.51	0.19	0.16	0.10	0.00	-0.08	-1.17
σ_v	2.47	2.17	1.58	0.57	0.47	0.26	0.24	0.18	3.76

σ_w – standard deviation in measurement error in income per capita (assumed throughout to be 0.20);
σ_u - standard deviation in measurement error in institutional quality (estimated by unobserved component model);
ρ – correlation between omitted variables in two structural equations (3.5) and (3.6);
γ - the impact of income per capita on institutional quality in the equation (3.6);
δ – the impact of instrument ("communism history") on institutional quality;
σ_v – estimated variance of residuals in the equation (3.6)

As can be seen from the Table 3, we obtain interesting results. The coefficient γ - impact of income on institutional quality – is negative, which means negative impact of income on quality of institutions. It reaches positive values only for negative correlation ρ = -0.55. This negative correlation implies that omitted variables in the equations (3.5) and (3.6) move institutional quality and income in different direction. One hardly can imagine such candidate for discriminating income and quality of institutions.

While doing this exercise for fixed ρ = 0 and varying σ_u, (bottom table) we get similar results about sign of the parameter γ. From lower part of Table 3, γ reaches positive values only for large measurement error in income per capita. It switches from negative to positive sign only for $\sigma_u \approx 0.43$. If to consider that σ_u has an average value 0.2 for all transition countries with minimum 0.12 and maximum 0.74 (which is outlier for Bosnia-Herzegovina in the quality of "rule of law" in 1996), this break-even value of measurement error in institutional quality is hardly attainable.

If to do the same computation for individual governance clusters "voice and accountability", "regulatory quality" , "government effectiveness" and "rule of law" results are similar in terms of negative sign of coefficient γ[4]. These indicators can be assumed to reflect the broad notion of institutional quality as they are highly correlated among each other.

Taking into consideration that we do not have standard errors of estimates for γ, δ, σ_v , as they were obtained by numerical solving the system (3.21-3.23), this

[4] See in Appendix 3.

finding suggests negative or at least no positive , ceteris paribus, impact of income on quality of institutions in the transition countries during 1996-2002 period.

We can interpret the negative coefficient γ in the regression of institutions on income per capita as a negative partial correlation[5] between institutional quality and purely exogenous factors associated with income levels after controlling for our instruments. Taking into consideration that it is difficult to find such purely exogenous factors of income that correlated only with income level but not with institutional quality, we can not observe direct evidence of this negative partial correlation. That is, we are unlikely to find some variable which is positively correlated with income and negatively with institutions. In fact, were such purely exogenous factors of income to exist, they could be naturally used as instruments in direct identifying the effect of income on institutional quality in the equation (3.6) and there would be no need for so complicated method.

Thus, negative coefficient γ does not mean negative correlation between institutional quality and income per capita. This linear association includes argued negative feedback from income to institutions, remaining positive only due to overwhelming positive impact of institutions on income per capita.

Then, how we should explain this negative coefficient γ? In our interpretation of negative feedback of income on institutional quality we should be very cautious. We can only argue that an increase in income as a consequence of

[5] Partial correlation coefficient – a measure of the linear association between two variables when specified other variables are held constant. It is calculated as the correlation coefficient between the residuals obtained when the two variables in question are regressed on the variables to be held constant. Kennedy (1998).

economic development will not itself ensure an improvement in institutional quality that is very important for sustainable growth as was shown above.

This phenomenon has taken place in transition countries since most of them regain economic growth. Mainly, negative impact of income on institutional quality could be explained in terms of state capture in the transition countries. As long as the established elites within a particular country have private benefits from low-quality institutions, there is little reason to expect that higher incomes will lead to demands for better institutions. The examples of elite influence, cronyism and regulatory capture (Turkmenistan, Belarus, Azerbaijan, Ukraine) provide vivid examples of imaginary interests of elite in improving institutions.

Thus, good institutional environment is not a luxury good that only rich societies can afford it. Good governance is also not an automatic product of economic growth and can be achieved only through direct government intervention by means of institutional reforms. Lack of desire and will to improve current institutions will hamper the institutional change toward more efficient institutions despite of possible good economic development in particular country.

Chapter 5

CONCLUSIONS AND POLICY IMPLICATIONS

The importance of institutions in the economic performance has been emphasized only in recent studies. The impetus for this type of research was given by the lack of finding an appropriate explanation for economic failure of some developing countries especially transition ones to grow. The good prerequisites for economic growth such as initial conditions and production factor endowments appear not to be sufficient for sustainable growth since beginning of transformation from centrally planned to market economy. Good quality of institutions is shown to be a fundamental condition for an efficient functioning of market economy and sustainable economic growth.

The challenge of this work was to provide empirical evidence of importance of institutions for economic performance for transition countries in the short-run. While empirical studies rely on path dependence of evolution of institutions and use primarily cross-section framework, this cannot be assumed for transition countries as they still in search of their "optimum institutional matrix" and have significant institutional change.

Based on this study, it was shown that

1) Institutional quality indeed has significant change over past years in the transition countries, which is reflected in several reliable subjective measures of quality of institutions;

2) Institutional quality and incomes per capita are highly correlated not due to spurious common exogenous factor that move them together but due to very significant influence of institutional change on income in the short-run;

3) There is no or even negative impact of income on institutional quality for transition countries in the short-run framework for 1996-2002 period;

The last finding implies the absence of a virtuous circle for transition countries: from higher incomes to better institutions, which in turn sustain economic development. The unwillingness of elites to improve institutions while having increased incomes results in this surprising finding. State capture, cronyism and the effect of vested interests do not lead to the improvement of institutions and their quality that are necessary for future sustainable growth.

Here, it should be mentioned that cross-country highly-aggregated data cannot substitute for in-depth country-specific institutional diagnostics as a basis for policy implication and advice how to improve institutional quality in a particular country. From above mentioned arguments and findings, we would suggest the following policy implications for transition countries, and particularly for Ukraine:

Economic development on itself is unable to ensure the improvement of institutions needed for sustainable economic growth, that is why, direct intervention are needed in forms of "institutional reforms":

- improve transparency (in designing budgets, media freedom, disclosure of votes by parliamentarians);

- regular monitor the actions of politicians and declaration of their assets through surveys and personal report cards;
- improve the control of corruption not only in legislative form but in executive as well;
- improve the enforcement of private contracts through revisiting and clearly defining property rights;
- pay attention for strengthening the civil society (develop non-governmental institutions, encourage active participation of citizens in economic and political events).

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Appendix 1

Description of the Kaufmann's 6 governance indicators[6]:

Av - "Voice and Accountability" - includes a number of indicators measuring various aspects of the political process, civil liberties and political rights. These indicators measure the extent to which citizens of a country are able to participate in the selection of governments. We also include in this category indicators measuring the independence of the media, which serves an important role in holding monitoring those in authority and holding them accountable for their actions.

Polstab - "Political Stability and Absence of Violence"- combines indicators which measure perceptions of the likelihood that the government in power will be destabilized or overthrown by possibly unconstitutional and/or violent means, including domestic violence and terrorism. This index reflect the idea that the quality of governance in a country is compromised by the likelihood of wrenching changes in government, which not only has a direct effect on the continuity of policies, but also at a deeper level undermines the ability of all citizens to peacefully select and replace those in power.

Goveffic - "Government Effectiveness" - combines responses on the quality of public service provision, the quality of the bureaucracy, the competence of civil servants, the independence of the civil service from political pressures, and the credibility of the government's commitment to policies. The main focus of this index is on "inputs" required for the government to be able to produce and implement good policies and deliver public goods.

[6] Taken from Kaufmann, Kraay and Mastruzzi (2003)

Regqua – "Regulatory quality"- focuses on the policies themselves. It includes measures of the incidence of market-unfriendly policies such as price controls or inadequate bank supervision, as well as perceptions of the burdens imposed by excessive regulation in areas such as foreign trade and business development.

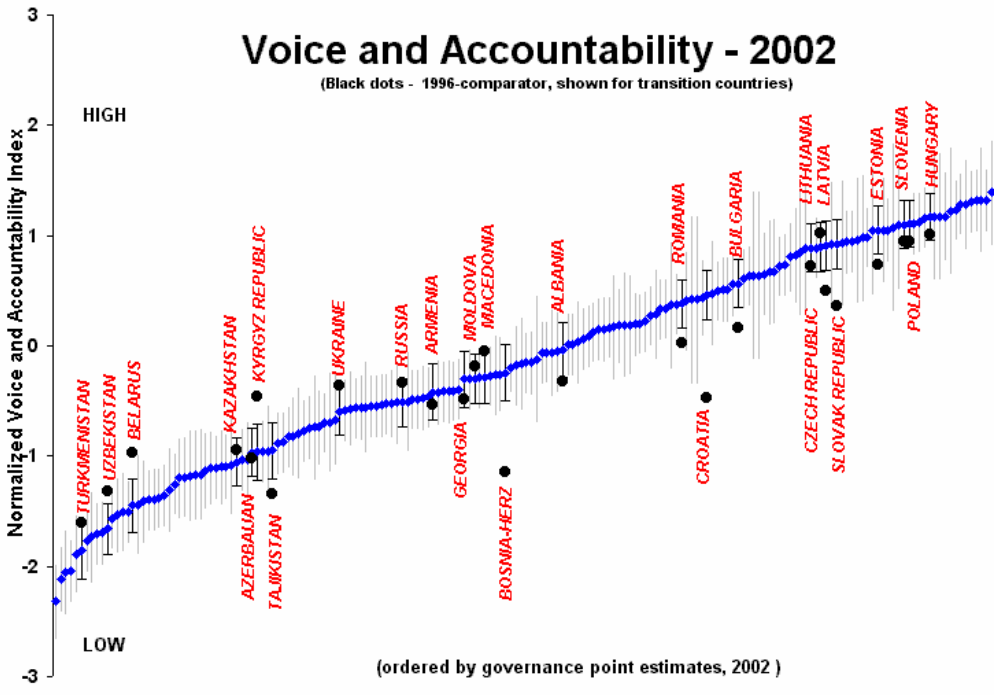
Rulelaw – "Rule of Law" - includes indicators which measure the extent to which agents have confidence in and abide by the rules of society. These include perceptions of the incidence of crime, the effectiveness and predictability of the judiciary, and the enforceability of contracts. This indicator measures the success of a society in developing an environment in which fair and predictable rules form the basis for economic and social interactions, and importantly, the extent to which property rights are protected.

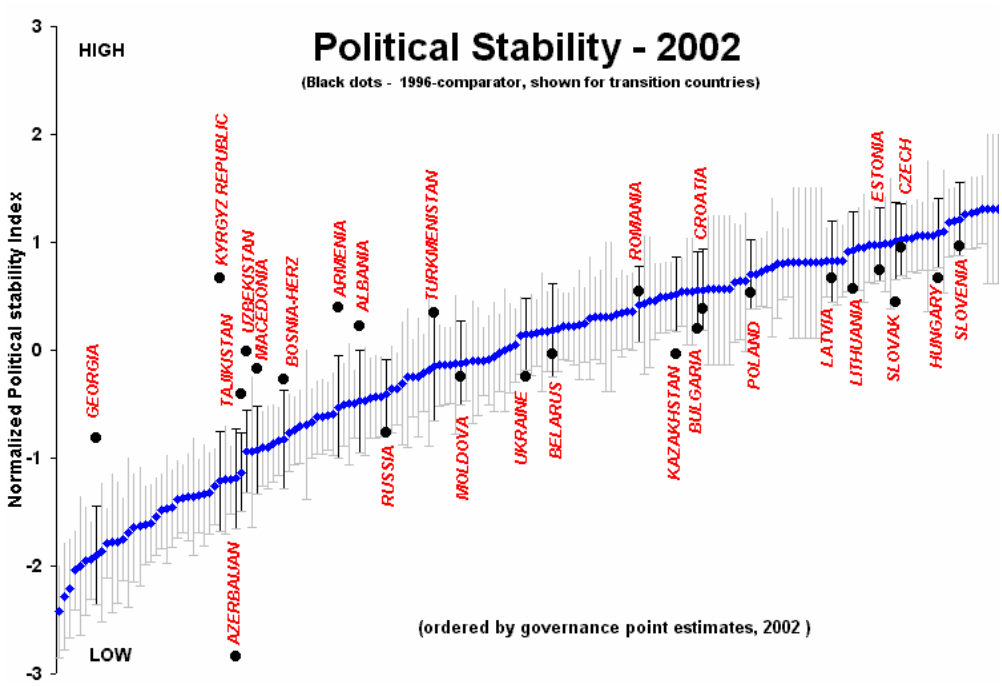
Contcorr – "Control of Corruption" measures perceptions of corruption, conventionally defined as the exercise of public power for private gain. Despite this straightforward focus, the particular aspect of corruption measured by the various sources differs somewhat, ranging from the frequency of "additional payments to get things done," to the effects of corruption on the business environment, to measuring "grand corruption" in the political arena or in the tendency of elite forms to engage in "state capture". The presence of corruption is often a manifestation of a lack of respect of both the corrupter (typically a private citizen or firm) and the corrupted (typically a public official or politician) for the rules which govern their interactions, and hence represents a failure of governance according to our definition.

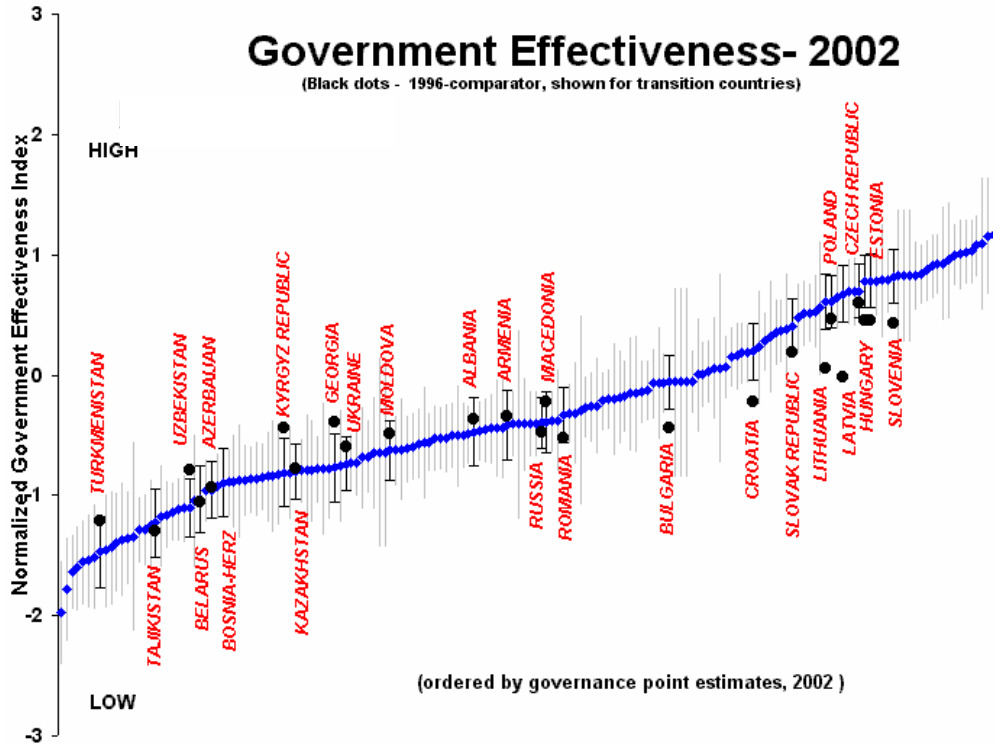
Appendix 2

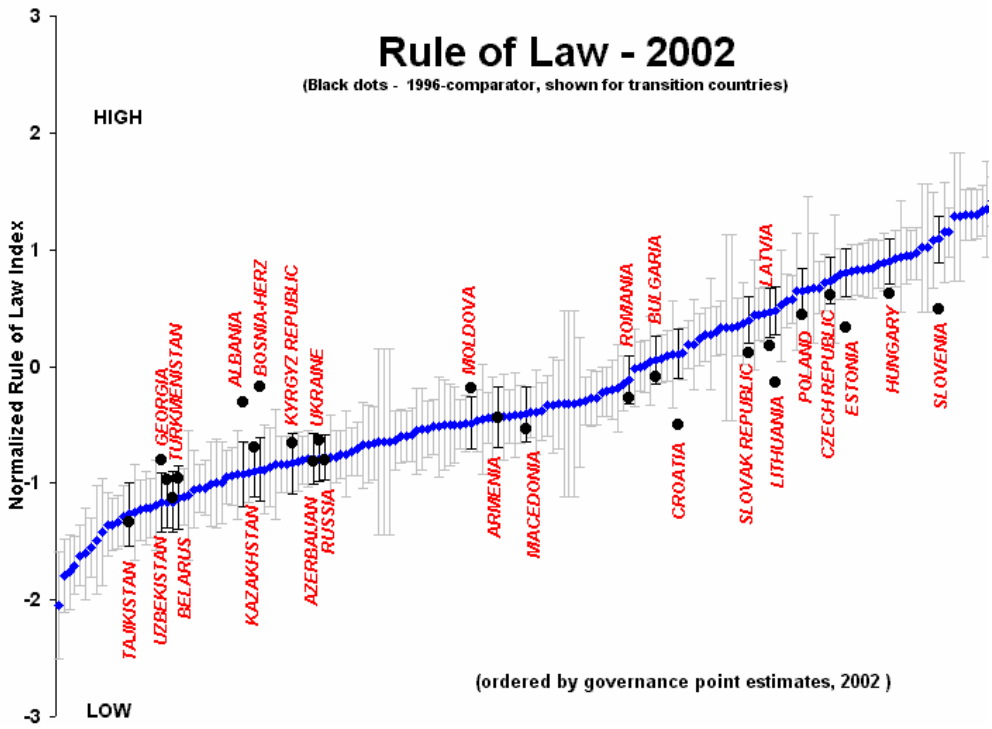
Figures 2-6 with point estimates and margin of errors for 5 governance clusters in 2002, with comparator estimate in 1996 year for transition countries.

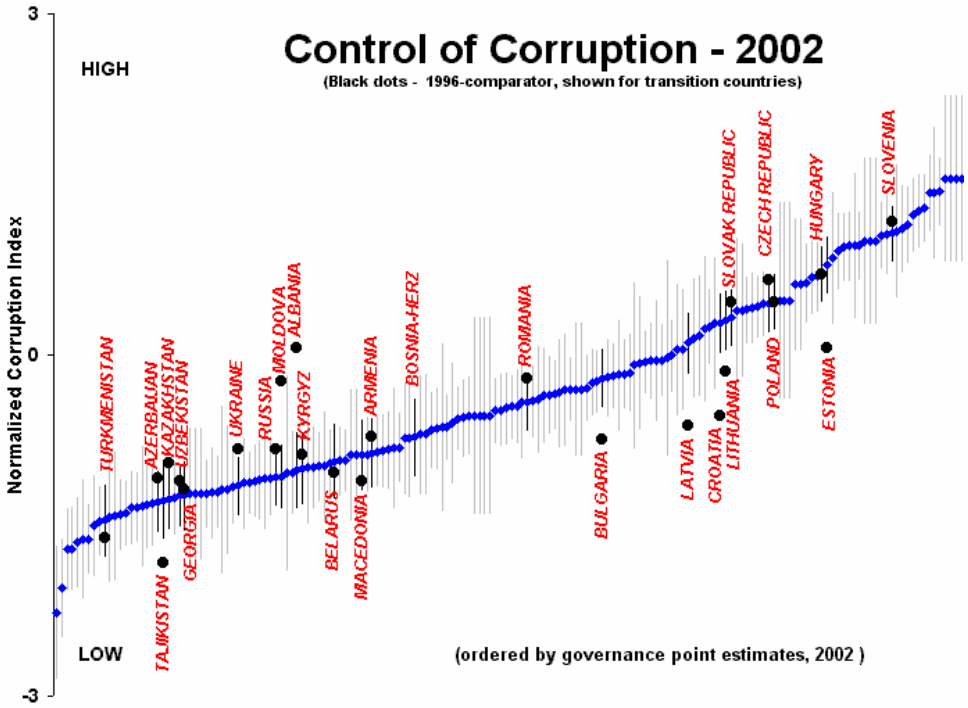
Note: Dots represent estimates for the 2002 particular governance indicator in world-wide sample. The thin vertical lines represent standard errors around these estimates for each transition country. Black dots represent the chosen 1996 year comparator. Source: World Bank Governance Indicators for 1996-2002, constructed by (Kaufmann, Kraay and Mastruzzi, 2003).




Political Stability - 2002
(Black dots - 1996-comparator, shown for transition countries)
HIGH
LOW
Normalized Political stability Index
(ordered by governance point estimates, 2002)
3
2
1
0
-1
-2
-3
GEORGIA
AZERBAIJAN
TAJIKISTAN
KYRGYZ REPUBLIC
UZBEKISTAN
MACEDONIA
BOSNIA-HERZ
ARMENIA
ALBANIA
RUSSIA
TURKMENISTAN
MOLDOVA
UKRAINE
BELARUS
ROMANIA
KAZAKHSTAN
BULGARIA
CROATIA
POLAND
LATVIA
LITHUANIA
SLOVAK
ESTONIA
CZECH
HUNGARY
SLOVENIA


Government Effectiveness- 2002
(Black dots - 1996-comparator, shown for transition countries)
HIGH
LOW
Normalized Government Effectiveness Index
(ordered by governance point estimates, 2002)
3
2
1
0
-1
-2
-3
TURKMENISTAN
TAJIKISTAN
UZBEKISTAN
BELARUS
AZERBAIJAN
BOSNIA-HERZ
KYRGYZ REPUBLIC
KAZAKHSTAN
GEORGIA
UKRAINE
MOLDOVA
ALBANIA
ARMENIA
RUSSIA
MACEDONIA
ROMANIA
BULGARIA
CROATIA
SLOVAK REPUBLIC
POLAND
CZECH REPUBLIC
LITHUANIA
ESTONIA
LATVIA
HUNGARY
SLOVENIA


Rule of Law - 2002
(Black dots - 1996-comparator, shown for transition countries)
HIGH
LOW
Normalized Rule of Law Index
3
2
1
0
-1
-2
-3
TAJIKISTAN
UZBEKISTAN
BELARUS
GEORGIA
TURKMENISTAN
KAZAKHSTAN
ALBANIA
BOSNIA-HERZ
AZERBAIJAN
RUSSIA
KYRGYZ REPUBLIC
UKRAINE
ARMENIA
MACEDONIA
MOLDOVA
CROATIA
ROMANIA
BULGARIA
SLOVAK REPUBLIC
LITHUANIA
LATVIA
POLAND
CZECH REPUBLIC
ESTONIA
HUNGARY
SLOVENIA
(ordered by governance point estimates, 2002)


Control of Corruption - 2002
(Black dots - 1996-comparator, shown for transition countries)
HIGH
LOW
Normalized Corruption Index
3
0
-3
TURKMENISTAN
TAJIKISTAN
AZERBAIJAN
KAZAKHSTAN
UZBEKISTAN
GEORGIA
UKRAINE
RUSSIA
MOLDOVA
ALBANIA
KYRGYZ
BELARUS
ARMENIA
MACEDONIA
BOSNIA-HERZ
ROMANIA
BULGARIA
LATVIA
CROATIA
LITHUANIA
SLOVAK REPUBLIC
POLAND
CZECH REPUBLIC
ESTONIA
HUNGARY
SLOVENIA
(ordered by governance point estimates, 2002)

Appendix 3

Table 4. Estimates of γ, δ, σ_v from equations (3.21-3.23).
For ***Kaufmann's governance cluster – "Government Effectiveness"***

Fixed: $\sigma_w = 0.2$ & $\sigma_u = 0.19$

ρ =	-0.58	-0.5	-0.4	-0.3	-0.2	-0.1	0	0.1
γ	**0.01**	-0.10	-0.27	-0.50	-0.85	-1.48	-2.96	-11.96
δ	0.14	0.16	0.20	0.26	0.34	0.49	0.84	2.95
σ_v	0.54	0.61	0.71	0.87	1.12	1.57	2.69	9.53

Fixed: $\sigma_w = 0.2$ & $\rho = 0$

	min	avg	max				
σ_u =	0.13	0.19	0.3	0.35	0.39	0.4	0.42
γ	-3.44	-2.96	-1.61	-0.80	-0.06	**0.14**	0.55
δ	0.95	0.84	0.52	0.33	0.15	0.11	0.01
σ_v	3.06	2.69	1.66	1.04	0.48	0.32	0.23

σ_w – standard deviation in measurement error in income per capita (assumed throughout to be 0.20);
σ_u - standard deviation in measurement error in institutional quality (estimated by unobserved component model);
ρ – correlation between omitted variables in two structural equations (3.5) and (3.6);
γ - the impact of income per capita on institutional quality in the equation (3.6);
δ – the impact of instrument ("communism history") on institutional quality;
σ_v – estimated variance of residuals in the equation (3.6)

Table 5. Estimates of γ, δ, σ_v from equations (3.21-3.23).
For ***Kaufmann's governance cluster – "Voice and Accountability"***

Fixed: $\sigma_w = 0.2$ & $\sigma_u = 0.17$

ρ =	-0.55	-0.5	-0.4	-0.3	-0.2	-0.1	0	0.1	0.2
γ	**0.01**	-0.10	-0.29	-0.53	-0.86	-1.36	-2.26	-4.43	-18.58
δ	0.19	0.22	0.27	0.32	0.40	0.53	0.74	1.27	4.70
σ_v	0.70	0.76	0.87	1.02	1.23	1.58	2.23	3.82	14.37

Fixed: $\sigma_w = 0.2$ & $\rho = 0$

	min	avg	max						
σ_u =	0.13	0.17	0.35	0.4	0.45	0.49	0.495	0.5	0.55
γ	-2.38	-2.26	-1.27	-0.88	-0.43	-0.03	**0.02**	0.07	0.62
δ	0.77	0.74	0.50	0.41	0.30	0.20	0.19	0.18	0.04
σ_v	2.32	2.23	1.49	1.19	0.86	0.56	0.52	0.48	0.04

σ_w – standard deviation in measurement error in income per capita (assumed throughout to be 0.20);
σ_u - standard deviation in measurement error in institutional quality (estimated by unobserved component model);
ρ – correlation between omitted variables in two structural equations (3.5) and (3.6);
γ - the impact of income per capita on institutional quality in the equation (3.6);
δ – the impact of instrument ("communism history") on institutional quality;
σ_v – estimated variance of residuals in the equation (3.6)

Table 6. Estimates of γ, δ, σ_v from equations (3.21-3.23).
For ***Kaufmann's governance cluster – "Regulatory Quality"***

Fixed: $\sigma_w = 0.2$ & $\sigma_u = 0.25$

ρ =	-0.55	-0.5	-0.45	-0.4	-0.3	-0.2	-0.1	0	0.1	0.2
γ	**0.03**	-0.05	-0.13	-0.22	-0.44	-0.72	-1.10	-1.70	-2.78	-5.52
δ	0.22	0.24	0.26	0.28	0.33	0.40	0.49	0.64	0.90	1.57
σ_v	0.78	0.82	0.87	0.92	1.05	1.22	1.48	1.91	2.71	4.78

Fixed: $\sigma_w = 0.2$ & $\rho = 0$

	min	avg	max							
σ_u =	0.16	0.25	0.3	0.35	0.4	0.45	0.5	0.55	0.58	0.6
γ	-1.92	-1.70	-1.53	-1.33	-1.10	-0.84	-0.55	-0.23	-0.03	**0.12**
δ	0.69	0.64	0.60	0.55	0.49	0.43	0.36	0.28	0.23	0.20
σ_v	2.08	1.91	1.78	1.63	1.45	1.25	1.03	0.78	0.62	0.51

σ_w – standard deviation in measurement error in income per capita (assumed throughout to be 0.20);
σ_u - standard deviation in measurement error in institutional quality (estimated by unobserved component model);
ρ – correlation between omitted variables in two structural equations (3.5) and (3.6);
γ - the impact of income per capita on institutional quality in the equation (3.6);
δ – the impact of instrument ("communism history") on institutional quality;
σ_v – estimated variance of residuals in the equation (3.6)

Table 7. Estimates of γ, δ, σ_v from equations (3.21-3.23).
For ***Kaufmann's governance cluster – "Rule of Law"***

Fixed: $\sigma_w = 0.2$ & $\sigma_u = 0.17$

ρ =	-0.5	-0.45	-0.4	-0.3	-0.2	-0.1	0	0.1	0.2
γ	**0.01**	-0.07	-0.15	-0.34	-0.59	-0.92	-1.42	-2.27	-4.20
δ	0.23	0.24	0.26	0.31	0.37	0.45	0.57	0.78	1.25
σ_v	0.80	0.84	0.88	1.00	1.16	1.39	1.75	2.40	3.90

Fixed: $\sigma_w = 0.2$ & $\rho = 0$

	min	avg							
σ_u =	0.12	0.17	0.3	0.4	0.45	0.5	0.55	0.57	0.6
γ	-1.54	-1.42	-1.27	-0.88	-0.65	-0.39	-0.11	0.01	0.20
δ	0.60	0.57	0.53	0.44	0.39	0.32	0.25	0.22	0.18
σ_v	1.84	1.75	1.63	1.32	1.14	0.93	0.71	0.61	0.45

σ_w – standard deviation in measurement error in income per capita (assumed throughout to be 0.20);
σ_u - standard deviation in measurement error in institutional quality (estimated by unobserved component model);
ρ – correlation between omitted variables in two structural equations (3.5) and (3.6);
γ - the impact of income per capita on institutional quality in the equation (3.6);
δ – the impact of instrument ("communism history") on institutional quality;
σ_v – estimated variance of residuals in the equation (3.6)

Appendix 4

Program in Maple 9.0 for numerical solving the system (3.21-3.23)

```
pi[1] = delta/(1-gamma_*beta);
sigma[2]^2=
(gamma_^2*sigma[e]^2+2*gamma_*rho*sigma[e]*sigma[v]+sigma[v]^2)
/((1-gamma_*beta)^2)+sigma[u]^2;

beta_OLS=
(delta^2*beta*sigma[x]^2+gamma_*sigma[e]^2+beta*sigma[v]^2+(1+g
amma_*beta)*rho*sigma[e]*sigma[v])/(delta^2*sigma[x]^2+gamma_^2
*sigma[e]^2+sigma[v]^2+2*gamma_*rho*sigma[e]*sigma[v]+(1-
gamma_*beta)^2*sigma[u]^2);
```

$$\pi_1 = \frac{\delta}{1 - gamma\_\,\beta}$$

$$\sigma_2^{\,2} = \frac{gamma\_^{\,2}\,\sigma_e^{\,2} + 2\,gamma\_\,\rho\,\sigma_e\,\sigma_v + \sigma_v^{\,2}}{(1 - gamma\_\,\beta)^2} + \sigma_u^{\,2}$$

$$beta\_OLS = \frac{\delta^2\,\beta\,\sigma_x^{\,2} + gamma\_\,\sigma_e^{\,2} + \beta\,\sigma_v^{\,2} + (1 + gamma\_\,\beta)\,\rho\,\sigma_e\,\sigma_v}{\delta^2\,\sigma_x^{\,2} + gamma\_^{\,2}\,\sigma_e^{\,2} + \sigma_v^{\,2} + 2\,gamma\_\,\rho\,\sigma_e\,\sigma_v + (1 - gamma\_\,\beta)^2\,\sigma_u^{\,2}}$$

```
alpha:=  8.758435;
beta :=   1.411009;
beta_OLS := .822267  ;
pi[0]:= -.4421075;
pi[1] :=.1667297;
sigma[x] :=  .8835984;
sigma[2]:= sqrt((.63149729)^2+(.14139024)^2);
sigma[total]:= sqrt((.66517333)^2+(.23167416)^2);
sigma[e]:=sqrt(          (sigma[total])^2-(beta)^2*(sigma[u])^2-
(sigma[w])^2);
a:= 1/beta;
sigma[u] := 0.2;
sigma[w]:=0.2;
rho:=0.2;

R0 := solve({
pi[1]=delta/(1-gamma_*beta),
sigma[2]^2=
(gamma_^2*sigma[e]^2+2*gamma_*rho*sigma[e]*sigma[v]+sigma[v]^2)
/(1-gamma_*beta)^2+sigma[u]^2,
beta_OLS=
(delta^2*beta*sigma[x]^2+gamma_*sigma[e]^2+beta*sigma[v]^2+(1+g
amma_*beta)*rho*sigma[e]*sigma[v])/(delta^2*sigma[x]^2+gamma_^2
*sigma[e]^2+sigma[v]^2+2*gamma_*rho*sigma[e]*sigma[v]+(1-
gamma_*beta)^2*sigma[u]^2)}, {gamma_,delta,sigma[v]} )
```