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Productivity and the Investment Climate: What Matters Most?

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Abstract

This paper explores the links between the investment climate and firm-level productivity and attempts to identify which dimensions of the investment climate matter most for productivity. The analysis is based on data collected in a recent Investment Climate survey of garment and food processing firms across five countries in Eastern Europe and Central Asia. The paper uses the first principal components of a series of indicators to summarize broad aspects of the investment climate and identify those most important in determining productivity. The results indicate that competitive pressure is the most critical factor in the investment climate, accounting for more variation in firm-level productivity than infrastructure provision or issues related to government rent seeking and bureaucratic burden. This suggests that to improve productivity, increase output, and reduce poverty, policymakers should focus reform efforts on removing barriers to entry and creating open, highly competitive markets.

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Productivity growth is the sine qua non for economic growth and consequently poverty alleviation. While factor accumulation is important, increases in capital and labor inputs alone do not explain cross-country differences in growth. Economic research has shown that improvements in the efficiency with which countries use their inputs—their total factor productivity (TFP), —explains most of the increase in output for fast-growing economies. No country has experienced sustained economic growth without also achieving rapid gains in productivity. The questions then for policymakers are these: What determinants of productivity cause producers in one country to be more efficient than those in competitor countries? And where should reform efforts be targeted to have the greatest impact on productivity and thus poverty reduction?

In a global economy where technology diffuses rapidly and capital is mobile, the persistence of productivity differences among countries can be largely explained by differences in the investment climate—the policy, institutional, and regulatory environment in which businesses must operate. Countries where property rights are secure, the government provides efficient services, and infrastructure is well developed are considered to have a good investment climate. And a good investment climate reduces the cost of doing business and leads to higher and more certain returns on investment.

But merely knowing that the investment climate matters is not enough. Policymakers are constrained by limited resources, and the path of reform is difficult and often slow. While some policy reforms can be instituted relatively quickly, many changes—such as building infrastructure and improving the quality of the workforce—take years. To be most effective, policymakers must be able to prioritize and direct their efforts to where they will have the largest and quickest impact.

This paper directly links the investment climate to firm performance and identifies dimensions of the investment climate that account for cross-country differences in productivity. And it presents evidence that competitive pressure is the most important of these dimensions in determining productivity and thus the area where policymakers should first focus their reform efforts. In highly competitive and dynamic economies, inefficient firms are driven out and surviving businesses are forced to seek continuous improvement. This effect has been clearly illustrated in such countries as China and India, which have made enormous gains in productivity after liberalizing their markets and opening them to the world economy.

Many studies have linked institutions and growth at the macroeconomic level (see Hall and Jones 1999). These studies rely on cross-country samples and use proxies at the country level for such factors as government efficiency, policy uncertainty, and the security of property rights. The investment climate approach, a closely related concept, strengthens the institutional literature by providing microeconomic foundations. This paper follows the lead of Dollar, Hallward-Driemeier, and Mengistae (2003) in using data from recent World Bank Investment Climate Surveys (ICS) to directly link indicators of the investment climate to firm-level productivity. It uses data from a recently completed survey of five transition economies in Eastern Europe and Central Asia to estimate total factor productivity and econometrically demonstrate the impact of the investment climate on productivity.

But this paper also goes a step further than previous earlier papers, and ranks the broad measures of the investment climate by their relative importance in explaining the variation in productivity across countries. This ranking technique can help policymakers use the results of the productivity analysis to design and implement policies for creating a pro-growth, and thus pro-poor, investment climate.

The Data

The data used for this study were drawn from an investment climate survey conducted by the World Bank in 2003 across five transition countries: the Kyrgyz Republic, Moldova, Poland, Tajikistan, and Uzbekistan. The survey used an identical instrument in each country to conduct face-to-face interviews with firms' managers and bookkeepers or accountants. The questionnaire was similar to that used in the Business Environment and Enterprise Productivity Survey conducted by the European Bank for Reconstruction and Development and World Bank in 2002. But it was amended to collect accounting data needed to estimate TFP and to improve comparability with the World Bank's core productivity and investment climate survey instrument. The survey, known as the Business Environment and Enterprise Productivity Extension Survey, was wide ranging: in addition to the accounting data, it sought both quantitative and qualitative information on investment climate indicators, including managers' perceptions of the business environment.

The survey was conducted simultaneously across all five countries, making a useful point-in-time comparison.[1] In each country a sample of 100 enterprises was drawn randomly from all size categories, with the sample equally split between enterprises whose main operations were in the garment sector and those whose main operations were in food processing. As far as was possible, the food processing sample was drawn from firms classified under NACE code 15.1 (production and preserving of meat and meat products).

Restricting the sample to two sectors helped ensure the accuracy of the productivity estimation. Both sectors produce tradable goods in reasonably competitive markets. Firms in the sample were therefore likely to face common prices, reducing the chance that the nominal value of output (and thus productivity) was inflated because of market power. Since the sectors are narrowly focused, it is also likely that the selected firms were using similar technologies. This leads to a more homogeneous production function and makes it easier to attribute the residual to differences in efficiency rather than differences in technology or market structure.

Although over 500 firms were surveyed, many did not report the full range of investment climate measures needed for the study. Others were engaged only in part in garment production or food processing, deriving the rest of their earnings from services, trading,

[1] The survey was administered and supervised in all five countries by a single firm, and the enumerators underwent training together to reduce variation among countries due to differences in implementation methodologies. Because of worries about survey fatigue following the large Business Environment and Enterprise Productivity Survey less than a year earlier, the sample was limited to 100 firms in each country.

or other types of activities. Still others reported numbers that were not credible, particularly in response to questions on firm performance and labor inputs. Once outliers, incomplete observations and observations on firms that were not solely manufacturers were removed, 362 observations remained—192 in food processing and 170 in garments (see appendix tables A1.1 and A1.2 for descriptive statistics).

Transition and the Investment Climate

The five transition countries in the sample provide a unique opportunity to explore the impact of the investment climate and liberalization efforts. At independence all five countries inherited centrally planned economies with heavily distorted markets. But their response to this situation varied.

Poland moved aggressively to liberalize and institute market reforms. It rapidly transferred productive assets to private hands, welcomed foreign investment, allowed easy entry of new startups, reduced government regulations, and concentrated on improving the regulatory environment for private business.

At the other extreme, Uzbekistan took a much more conservative approach. The government continues to direct investment and allocates a substantial share of the country's economic resources. Foreign investment and foreign trade (beyond commodities) have grown slowly. Uzbek officials claim that the slow pace of reform softened the shock of transition and reduced the fall in output suffered by all transition economies when they lost guaranteed markets and subsidies.[2] However, the failure to adopt market reforms and encourage competition has choked off growth during the recovery and led to lower productivity levels.[3]

The other Central Asian countries, the Kyrgyz Republic and Tajikistan, appear to have an investment climate more like Uzbekistan's than Poland's, while Moldova's investment climate appears to be somewhere in the middle. Managers in the Moldovan sample report higher levels of competition and better infrastructure than those in the Central Asian countries, but worse performance on these measures than in Poland.

The transition economies inherited infrastructure of poorer quality than that in OECD countries, though of much better quality than that in most developing countries. All the transition economies had a well-educated workforce, with very high literacy. In the 2002 Business Environment and Enterprise Productivity Survey managers in most of the 27 transition economies included reported that the biggest constraints to private sector operations centered on governance issues, the regulatory regime and the uncertain policy environment.

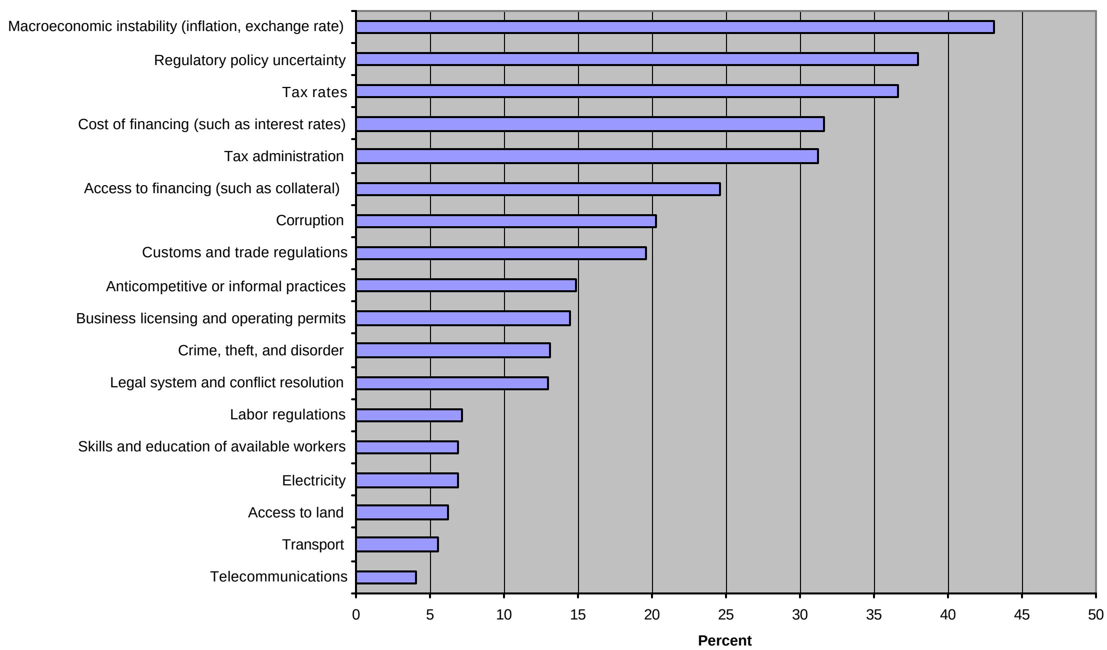
For managers in the smaller sample of transition economies used in this paper, macroeconomic uncertainty was the biggest concern, reflecting the transition experience

[2] This information comes from interviews with Uzbek officials conducted as part of the World Bank's recent investment climate assessment in Uzbekistan.

[3] Uzbekistan suffered a smaller decline in output than any other transition economy. Uzbek output at its lowest point, in 1995, was still 85 percent of the level in 1991. Several factors may have mitigated the decline in output. The country had a smaller industrial base to begin with, its main exports were commodities (such as gold and cotton) that were easy to reorient for export to the world market, and oil and energy production increased enough during this period to make Uzbekistan self-sufficient in these resources.

(figure 1). (While there were some differences among countries, the rank ordering was similar across countries, so only the sample averages are reported here.) As in almost every country where investment climate surveys have been conducted, managers also perceived both the cost and accessibility of finance as a problem. And while they perceived infrastructure, access to resources, and technology as important constraints, they considered them less so than the policy environment.

Figure 1 Share of Firms Identifying Each Investment Climate Factor as a Major Constraint in Five Transition Economies



Note: Figure shows sample averages across the Kyrgyz Republic, Moldova, Poland, Tajikistan, and Uzbekistan.
Source: World Bank, Business Environment and Enterprise Productivity Extension Survey, 2003.
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Measuring the Investment Climate

Managers' broad perceptions of the investment climate give some indication of the most constraining business problems. But to understand the effect of the investment climate on firm performance requires specific measures of indicators. The investment climate survey collected data on a wide variety of quantitative as well as qualitative, or perception-based, indicators of the investment climate. While perception based indicators are useful, they must be augmented by quantitative indicators to give an accurate picture of the investment climate.

The reason is that managers have different frames of reference. An issue perceived as a major problem in one country may actually impose a smaller cost on businesses in that country than it does in a country where the problem is rated as merely moderate. So whenever possible it is important to gather quantitative measures of a problem (for example, how much companies pay in bribes on average) rather than just perceptions (how big a problem corruption is).

There are a vast number of possible indicators and the challenge is to narrow this large selection down to a manageable number that accurately describe the investment climate. In doing so, researchers face two major problems: endogeneity and multicollinearity.

This analysis treats the investment climate indicators as exogenous determinants of firms' performance. However, high-performing firms may be proactive in reducing their own investment climate constraints, producing a simultaneity bias in the estimation exercise. For example, a well-managed, productive firm may be able to work with authorities to limit inspections or secure a more reliable power supply. To address this endogeneity issue, the empirical analysis uses average investment climate indicators taken across firms in the same country, region, and sector. To the extent that individual firms are less likely to influence averages and provided that the sample cuts are sensibly chosen to reflect “pockets” of business environments, using averages is a valid way to instrument out the simultaneity problem.[4]

Among the possible investment climate indicators are multiple indicators that address a similar major issue, giving rise to multicollinearity. For example, many indicators relate to the quality of infrastructure—such as the prevalence of e-mail, the number of firms with their own power generators and the number of power outages in a given period. It is not clear how important any particular indicator is. The quality of infrastructure affects all firms, but which indicator matters most to a particular firm depends on its circumstances and its production technique. Typically, all of the indicators that address a broad dimension of the investment climate are highly correlated and move together. Consequently, it is not possible to know the importance of any one particular indicator since it may be serving as a proxy for other, more relevant variables.

Investment climate is a vast concept, and a tension naturally arises between its breadth and a parsimonious quantitative approach. From a practical perspective this study is prevented from working with as many investment climate indicators as would be preferred, since correlation among them will eventually disrupt the econometric exercise. One solution used in past studies is to restrict the analysis to a subset of investment climate indicators and accept the omitted variable bias. Although this approach can yield

[4] Another tradeoff that researchers face when deciding how many criteria on which to base the sample cut is that a thick cut will mitigate the endogeneity problem but generate little variation in the regressor, while a thin cut will have the opposite effect.

significant results, there are always questions of whether the IC variables used provide a representative description of the investment climate and whether the strength of the results is merely due to the particular selection of indicators.

In an attempt to overcome both problems, this study reduces the dimensionality of the data by using principal component analysis.[5] The approach first identifies broad aspects of the investment climate measured by the survey, collects a few series that map into each of them, and then extracts the "main variation" commanded by each aspect through the use of their respective first principal component. It essentially treats all of the underlying investment climate indicators as proxies for three broad measures of the investment climate described below: "rent predation", "infrastructure", and "competition".

Rent predation

The rent predation measure is constructed from survey responses on the costs imposed by bribery, bureaucracy, and inspections. Higher levels of predation typically have an adverse effect on performance.

- The cost of bribery—or the *bribe tax*—is the estimated amount of unofficial payments firms typically made to public officials in the previous year as a percentage of sales.
- The cost of bureaucracy—or the *time tax*—is the percentage of senior management time spent in dealing with public officials on the application and interpretation of laws and regulations and on getting or maintaining access to

[5] See Manly (1994) for an intuitive introduction to principal component analysis and Mardia, Kent, and Bibby (1997) for a more technical exposition.

public services. The time tax is a proxy for how burdensome government red tape is.

- The cost of *inspections* is measured as the number of days in the previous year spent on inspections and required meetings with government officials. Higher numbers of inspections lower performance because more inspections provide more opportunities for rent seeking; it can generally be assumed that the more inspections there are, the more likely they are to be rent seeking activities.

Table 1 Mean Indicators of Rent Predation by Country

Indicator	Kyrgyz Republic	Moldova	Poland	Tajikistan	Uzbekistan
Inspections (days)	32.1	21.7	16.8	12.9	15.2
Bribe tax (percent)	2.1	1.2	0.4	1.6	0.5
Time tax (percent)	8.3	3.1	9.4	2.4	8.3

Note: See text for definitions of indicators.
Source: World Bank, Business Environment and Enterprise Productivity Extension Survey, 2003.

The Kyrgyz Republic appears to perform the worst on the rent predation measure, with the highest values for inspections and the bribe tax (table 1). Poland has the lowest bribe tax but the highest time tax. Still, it is difficult to say that any one country suffers from the highest level of rent predation. It has been suggested that there may be large measurement error because in some countries managers are unwilling to talk about government rent seeking. However, the interview teams provided no evidence of systematic measurement error.

Infrastructure

The infrastructure measure indicates the effect of inadequate infrastructure on firm performance. A composite measure of the average number of days firms experienced interruptions in power, water, and telephone service in the last year, it serves as a proxy for the overall state of infrastructure.

The European countries clearly have a superior infrastructure, with Poland's stronger than Moldova's (table 2). Firms in Poland, on average, experienced only 1.5 power outages during the previous year and those in Moldova 2.3—compared with 37.3 in Tajikistan and 15.8 in the Kyrgyz Republic. Water and telephone outages tell a similar story. Firms in Uzbekistan reported fewer service outages on average than those in the other Central Asian countries, but still substantially more than those in the European countries.

These microeconomic results mirror country-level data. For example, the European countries had the most telephone mainlines per 1,000 people and the most Internet hosts per 10,000 people in 2000, with Poland having the most developed telecommunications sector.

Table 2 Mean Indicators of Infrastructure by Country

Indicator	Kyrgyz Republic	Moldova	Poland	Tajikistan	Uzbekistan
Service interruptions in previous year					
Power	15.8	2.3	1.5	37.3	7.7
Water	2.4	1.0	0.2	1.8	2.0
Telephone	1.9	4.3	0.5	6.4	1.8
Telephone mainlines per 1000 people, 2000	77		283	36	67
Internet hosts per 10,000 people, 2000	6.2	4.0	67.2	0.4	0.1

Source: For service interruptions, World Bank, Business Environment and Enterprise Productivity Extension Survey, 2003; for other data, World Bank, World Development Indicators database.

Competition

Competitive pressure is the driving force behind productivity improvements. In closed economies with sheltered markets enterprises have little incentive to invest in new products or cost saving measures. But in open, highly competitive economies enterprises must constantly strive to improve their competitive position to survive. The competition measure uses a series of perception questions regarding the importance of domestic and foreign competition for decisions to introduce new products and to reduce the costs of existing products. It also includes a question on the number of competitors in firms' main product line as a gauge of market power.

Table 3 Mean Indicators of Competition by Country

Indicator	Kyrgyz Republic	Moldova	Poland	Tajikistan	Uzbekistan
Importance of domestic competition for decisions[a]					
To introduce new products	2.7	2.6	3.3	2.7	2.4
To reduce costs	3.0	2.9	3.3	2.6	2.1
Importance of foreign competition for decisions[a]					
To introduce new products	2.4	2.2	2.9	2.0	1.8
To reduce costs	2.4	2.5	2.9	2.0	1.7
Competitors in main product line	28.8	43.6	63.1	47.8	32.3
Average net inflows of foreign direct investment (percentage of GDP), 1996–2001	2.9	4.0	5.1	1.9	0.8

a. Average ranking by firms on a scale of 1 (not at all important) to 4 (very important).
Source: For foreign direct investment, World Bank, World Development Indicators database; for all other data, World Bank, Business Environment and Enterprise Productivity Extension Survey, 2003.

By all measures based on managers' perceptions, Poland has a much more competitive economy than the Central Asian countries or even Moldova (table the 3). On average Polish managers ranked pressure from domestic competitors as 3.3 in importance (with 3 meaning fairly important and 4 very important), while in other countries average rankings ranged between 2.14 and 3.0. As expected, the lowest scores appeared in Uzbekistan, where government policies have restricted competition. By contrast, Poland has taken a number of steps to liberalize and open its economy to competition, many in preparation for joining the European Union. Poland has privatized all but some of its older, heavy industries (such as mining and shipbuilding), and many new businesses have entered the market since transition began.

The rate of foreign direct investment is one way to illustrate the relative openness of the European economies in the sample. In 1996–2001 net inflows of foreign direct investment averaged 5.1 percent of GDP in Poland and 4.0 percent in Moldova, but only 1.9 percent in Tajikistan and 0.8 percent in Uzbekistan.

Principal Components and the Underlying Investment Climate Variables

Principal component analysis is used to pin down weights for a linear combination of the underlying investment climate variables such that the resulting series (the first principal component) has maximum variance. Intuitively, the goal is to construct one artificial series that can summarize the behavior of a group of underlying variables that describe similar aspects of the investment climate. Only the first principal components are used because having a single series for each dimension of the investment climate will be crucial when the analysis attempts to rank the dimensions by their relative ability to "explain" the variation in firm-level productivity.[6]

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[6] The analysis is restricted to the first principal components because they adequately characterize the broad dimensions of investment climate yet yield a parsimonious list of variables that explain the effect of the investment climate on firm performance. The eigenvalues associated with each of the first principal components are greater than one, while those associated with each of the second principal components are

Since the first principal components are used to summarize different dimensions of the business environment, they can be expected to be correlated with the underlying (individual) investment climate variables. Indeed, the first principal components are strongly associated with their corresponding investment climate variables (averaged for each country-region-sector slice; table 4).

Table 4 Correlation between Investment Climate Variables and First Principal Components

Rent predation		Infrastructure		Competition	
Underlying variables	Correlation	Underlying variables	Correlation	Underlying variables	Correlation
Inspections	0.6811	Power	0.7624	Domestic, new products	0.6905
Bribe tax	0.2012	Water	0.3442	Foreign, new products	0.8779
Time tax	0.8114	Telephone	0.7297	Domestic, reduce costs	0.8709
				Foreign, reduce costs	0.8222
				Num. of Competitors	0.4639

Source: Authors' calculations.

Estimating Productivity

Firm-level productivity estimates are generated for the sample by fitting a Cobb-Douglas production function after pooling across sectors and countries. Equation 1 gives a general form of the production function:

$$(1) \quad Q = AK^a L^b M^d$$

Here A is a term that captures the influence of the investment climate on the production function. It is in effect the residual portion of output not accounted for by inputs of

either only slightly greater or less than one. This fact gives some assurance that relying only on the first principal component does not involve throwing away "too much" information.

capital (*K*), labor (*L*), and raw materials and fuel (*M*) and can be ascribed to the business climate. It is modeled here as a function of observable investment climate indicators, x. Taking logs, the equation for this general form can be written as:

$$(2) \quad q_i - ak_i - bl_i - dm = f(x_i)$$

The left side of this equation is conventionally known as total factor productivity (TFP), and in the model used here it is a function of the investment climate.

The concept of investment climate has an important country-specific component, and as a result, including country dummy variables in a regression may wash away much of the effects of the investment climate indicators. But it is important to take into account country-specific effects when estimating coefficients on capital and labor. The analysis thus proceeds in two steps. First the basic production function is estimated with country dummies but without investment climate measures. Then, using the coefficients from this regression, TFP is calculated and regressed on broad investment climate measures.

The production function is estimated in logs. In addition, it is assumed that firms in the sample are price takers and that they purchase capital and raw materials at world prices. Thus, the dollar value of capital and materials and the dollar value of output can be compared across countries. These are strong assumptions, but given the highly competitive nature of the selected sectors they are not unreasonable. Wage rates diverge across countries so that labor input is measured by the number of workers, not the value of labor used. The regressors include inputs (material, labor, and capital), capacity utilization, schooling, sectoral and country dummy variables. The basic model is augmented with capacity utilization to account for efficiency loss due to unused capacity and low market demand.[7] The schooling variable is a weighted average of education years of the workforce and captures elements of labor quality.[8] Nominal values are converted to U.S. dollars using nominal exchange rates.[9] The regression is estimated using ordinary least squares with White correction for heteroskedasticity and allows for clustering within countries. The specification is as follows:

$$(3)\quad \ln(Output_i) = cons + b_m \ln(Material_i) + b_l \ln(Labor_i) + b_c \ln(Capital_i) + b_u \ln(CapUtil_i) + b_s \ln(Schooling_i) + b_t SectoralDummy + \sum_{n=1}^{4} b_n D_n + e_i$$

The different production technologies used by the two sectors could mean a need to estimate separate equations for each sector. In an unreported exercise the equation is therefore estimated with sectoral dummy variables interacted with the input coefficients. The parameter estimates are not jointly significant, however. Consequently, the data are pooled across sectors to take advantage of a large sample size and the results of the production function estimation are reported in Table 5.

Moldova is chosen as the base country, and country-specific productivity gaps expressed in relative percentage terms are retrieved from the estimated coefficients on the country

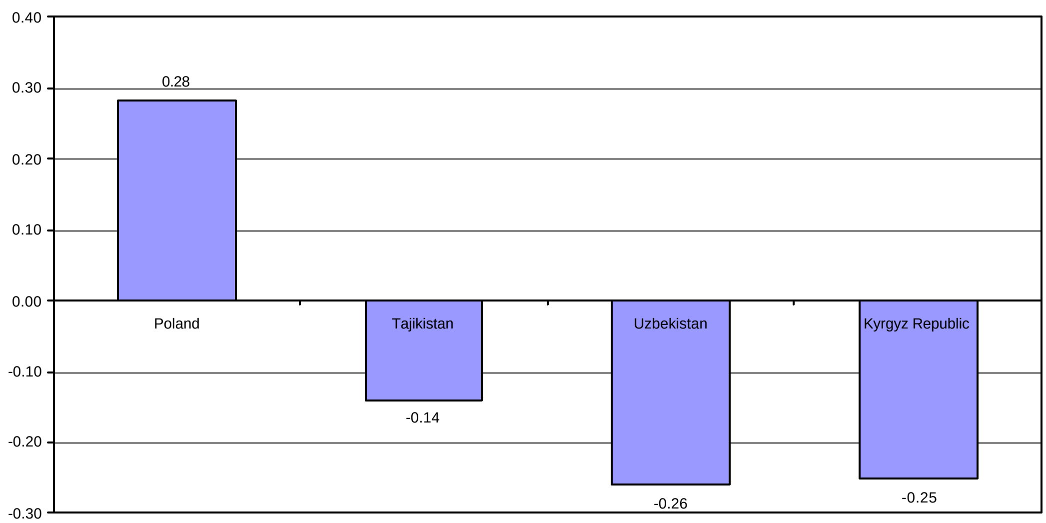
[7] Capacity utilization was estimated by simply asking managers what they considered their capacity utilization to be. No effort was made to define a standard number of shifts or correct for differences in the length of the workweek.

[8] There was no reliable information on worker training or experience in the Business Environment and Enterprise Productivity Extension Survey.

[9] Using nominal rather than real exchange rates introduces bias because many countries intervene to support the value of their currency. Uzbekistan in particular has an overvalued exchange rate. But in comparisons of international competitiveness nominal exchange rates make more sense because these are what exporters face.

dummy variables.[10] The results show large productivity gaps between countries (figure 2). Although the sample is drawn from enterprises in the same industries and using similar technologies, productivity is higher for enterprises in countries with a more competitive and less costly investment climate. Firms in Poland are 28 percent more efficient than those in Moldova, while firms in Uzbekistan, the least efficient, are 26 percent less efficient than those in Moldova.

Figure 2 Productivity Gaps between Countries with Moldova as the Base



Source: Authors' calculations.

In the second step the coefficients estimated in equation 3 are used to derive the measure of firm-level productivity:

$$(4) \quad \ln T\hat{F}P_i = \ln(Output_i) - \hat{b}_m \ln(Material_i) - \hat{b}_l \ln(Labor_i) - \hat{b}_c \ln(Capital_i) - \hat{b}_u \ln(CapUtil_i) - \hat{b}_s \ln(Schooling_i)$$

Table 5 Production Function Results

Ln (Output)	Coefficient	Standard error

[10] Productivity gap for country n = [exp (b_n) – 1] * 100, for any country n other than Moldova.

Ln (Material)	0.72*	0.0167
Ln (Labor)	0.22*	0.0172
Ln (Capital)	0.07*	0.0150
Ln (CapUtil)	0.08**	0.0339
Ln (Schooling)	0.40**	0.1456
Dummy Food	–0.005	0.0469
Poland	0.25*	0.0348
Tajikistan	–0.15*	0.0142
Uzbekistan	–0.30*	0.0163
Kyrgyz Republic	–0.29*	0.0291

* Significant at the 1 percent level.
** Significant at the 10 percent level.
Source: Authors' calculations.

Country dummies are intentionally not included in the second equation (since, as noted, including them washes away much of the effect of the investment climate variables). Their role in the analysis is simply to allow for cleaner estimates of input elasticities and coefficients on capacity utilization and schooling in the first regression.

The measure of performance (log-TFP) is regressed against control variables including age, percentage of sales exported, percentage of foreign ownership, and the first principal components of each of the three broad dimensions of investment climate—rent predation, infrastructure, and competition. The level of exports is included because it is often argued that exporting is a learning mechanism, which enables companies to improve productivity by learning from customers and facing international competition. Likewise, foreign ownership may increase productivity if foreign investors bring new technologies and management techniques.

The analysis uses ordinary least squares with White correction for heteroskedasticity and allows for clustering within countries. The specification is as follows:

(5) $\ln TFP_i = Cons + b_1 Age_i + b_2 Exports_i + b_3 Foreign\ Ownership_i + b_4 \mathrm{Re}\,nt\_predation + b_5 Infrastructure_b + b_6 Competition_b + e_i$

The rent predation and infrastructure variables are constructed in a such way that higher values denote worse conditions, while the opposite is true for the competition variable. The results confirm the expected signs of the investment climate variables and clearly indicate that investment climate (understood as the joint significance of the investment climate regressors) matters for firm performance (table 6).[11]

Table 6 Total Factor Productivity Regression Results

Regressor	Coefficient	Standard error
Age	0.0004131	0.0022152
Foreign ownership	0.0012388	0.0009047
Exports (percentage of sales)	0.00038	0.0009567
Rent Predation	–0.1515815*	0.0315022
Infrastructure	–0.1475655*	0.0312063
Competition	0.1215699*	0.0038598
Constant	–0.7475619*	0.0449609

* Significant at the 1 percent level.
Note: R2 is 0.44. Using the Wald test, the null hypothesis that coefficients on investment climate regressors are jointly equal to zero is rejected at the 1 percent level.
Source: Authors' calculations.

What Matters Most? Competition

The preceding analysis clearly demonstrates the importance of competition, rent predation, and infrastructure in determining firm-level productivity. However, for the analysis to be useful requires another step—identifying the relative importance of these dimensions of the investment climate and thus the areas of reform that will generate the largest payoff. Because the investment climate dimensions are principal components,

[11] Unreported results from a specification that directly includes a number of investment climate indicators indicate that foreign ownership and exporting behavior are significant. But when the principal component approach, which better captures the overall investment climate, is used, these two variables no longer appear to be significant.

their coefficients do not have a scale that can be easily interpreted (Greene 2000, p. 258). Moreover, because many of the indicators that comprise the investment climate dimensions are qualitative, it is unclear how to construe changes in them.

To guide policy, we need to be able to rank the relative importance of each of the investment climate dimensions in explaining the variation in productivity across firms. However, there is no easy way of assessing relative performance of regressors in a multiple regression context when, as is certainly the case here, they are not completely independent. One way is to take a fraction-of-variance approach, but this requires a natural ordering of the regressors, something not present in this case. Another possible solution , and the one chosen here, is to apply a methodology proposed by Kruskal (1987).[12]

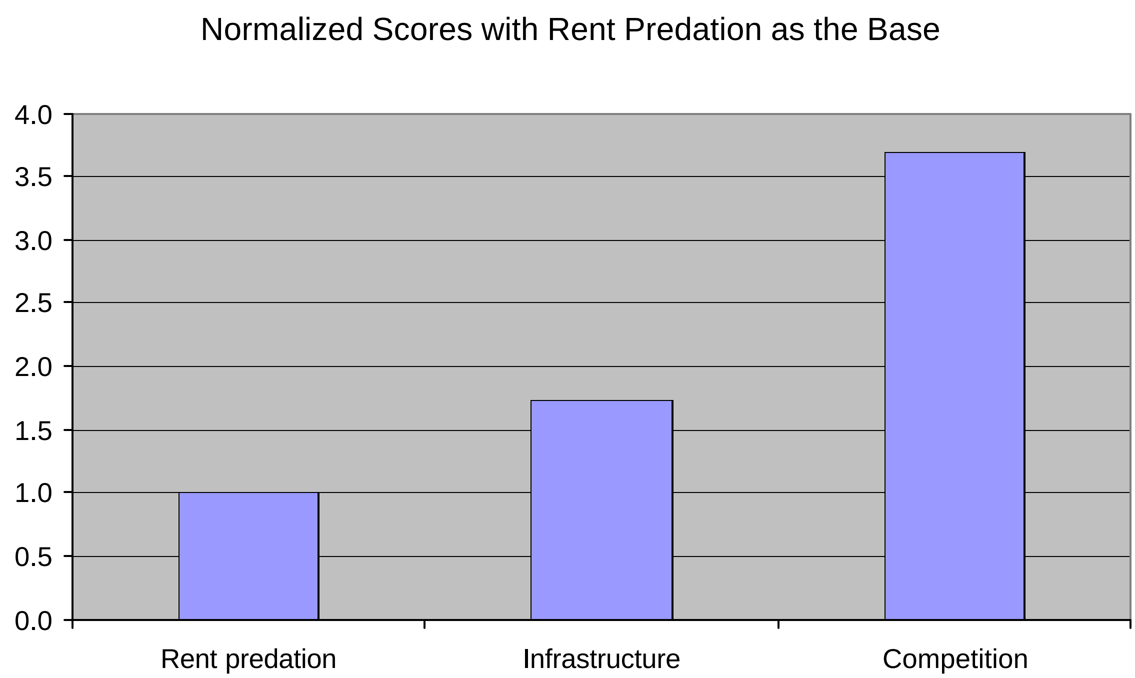
Kruskal's approach builds on the simple concept of partial correlation coefficients, which can be used whenever it is necessary to measure the association between two variables after accounting for the common influence of other factors. A one-dimensional index capturing the relative explanatory power of each investment climate regressor is calculated by averaging over a sequence of squared partial correlation coefficients generated from all possible orderings in which such regressors can be considered (see appendix 2 for details on the procedure used).

The normalized index scores indicate that competition accounts for far more variation in firm-level productivity than infrastructure and rent predation (figure 3). The competition

[12] See also Johnston and DiNardo (1997) for an exposition of Kruskal's methodology.

measure explains more than 3.7 times as much variation as the rent predation measure. Next in importance is infrastructure, which explains 1.73 times as much variation as rent predation, though less than half as much as competition.

Figure 3



Source: Authors' calculations.

Conclusion

This paper not only provides strong evidence of the link between the investment climate and firm-level productivity but also demonstrates an approach for ranking different dimensions of the investment climate. The results indicate that competitive pressure is the most important factor driving productivity levels. A good supporting infrastructure and a nonpredatory regulatory environment are invaluable, but they are not sufficient. It is pressure from market competition that drives firms to improve efficiency. Open economies that foster such pressure will see faster growth and greater poverty alleviation.

This finding suggests that the relatively quick steps governments can take to increase competition will have a big payoff in firm performance—even as the slow, expensive process of upgrading infrastructure takes place. It also indicates that high levels of fixed investment, especially in infrastructure, will not be enough to spur growth. Uzbekistan, for example, has had relatively high levels of fixed investment but low productivity growth, suggesting that the investment expenditures have not been particularly efficient. Investment must be accompanied by liberalization, which allows market competition to ensure that resources are efficiently allocated.

Appendix 1 Summary Statistics

Table A1.1 Firm Characteristics, Full Sample

Characteristic	Observations
Firm size (employees)	
0–49	257
50–99	38
100–249	36
250 +	31
Ownership	
Domestic	334
Some foreign	28
Exports (percentage of sales)	
None	298
0–9	5
10–49	21
50–99	30
100	8

Table A1.2 Country Descriptive Statistics

Country	Characteristic	Observations	Mean	Median
Kyrgyz Republic	Firm size (employees)	66	105.1	30.5
	Foreign ownership (percent)	66	3.8	0
	Exports (percentage of sales)	66	11.5	0
	Sales (thousands of U.S. dollars)	66	169.9	34.9
Moldova	Firm size (employees)	86	107.3	30
	Foreign ownership (percent)	86	4.5	0
	Exports (percentage of sales)	86	23.5	0
	Sales (thousands of U.S. dollars)	86	445.2	139.6
Poland	Firm size (employees)	67	64.4	20
	Foreign ownership (percent)	67	1.5	0
	Exports (percentage of sales)	67	8.0	0
	Sales (thousands of U.S. dollars)	67	2,070.7	490.2
Tajikistan	Firm size (employees)	61	19.2	7
	Foreign ownership (percent)	61	0	0
	Exports (percentage of sales)	61	0.3	0
	Sales (thousands of U.S. dollars)	61	32.0	12.9
Uzbekistan	Firm size (employees)	82	112.1	21.5
	Foreign ownership (percent)	82	13	0
	Exports (percentage of sales)	82	1.6	0
	Sales (thousands of U.S. dollars)	82	372.5	42.3
Total	Firm size (employees)	362	85.2	20
	Foreign ownership (percent)	362	5.0	0
	Exports (percentage of sales)	362	9.6	0
	Sales (thousands of U.S. dollars)	362	609.8	69.9

Appendix 2 Kruskal Methodology

There is no clear way to determine the relative importance of individual regressors in a multiple regression when there is no natural ordering to the regressors. However, Kruskal (1987) proposes an intuitive and practical solution, derived from basic statistical concepts, that attempts to deal with the ambiguity produced by the correlation structure of the explanatory variables. The procedure as implemented in this paper is as follows.

For each one of the three broad investment climate dimensions—rent predation, infrastructure, and competition—the analysis calculates the four different partial correlation coefficients arising from all permutations in which a particular dimension can be considered after holding all controls (age, exports, and foreign ownership) fixed. To further illustrate the procedure, let's consider rent predation. The goal is to study how much variation in firm-level productivity this dimension can account for after the effect of some firm characteristics is removed.

Because rent predation is likely to be correlated with the other two dimensions (infrastructure and competition), ambiguity arises when trying to determine how much variation each dimension commands. It is impossible to know whether the correlation between log-TFP and rent predation should be measured after or before removing the common influence of infrastructure, competition, or even both. That leaves four possible measures of correlation.

Ordering 1: Partial correlation coefficient between log-TFP and Rent Predation holding firm controls fixed.

Ordering 2: Partial correlation coefficient between log-TFP and Rent Predation holding firm controls and Infrastructure fixed.

Ordering 3: Partial correlation coefficient between log-TFP and Rent Predation holding firm controls and Competition fixed.

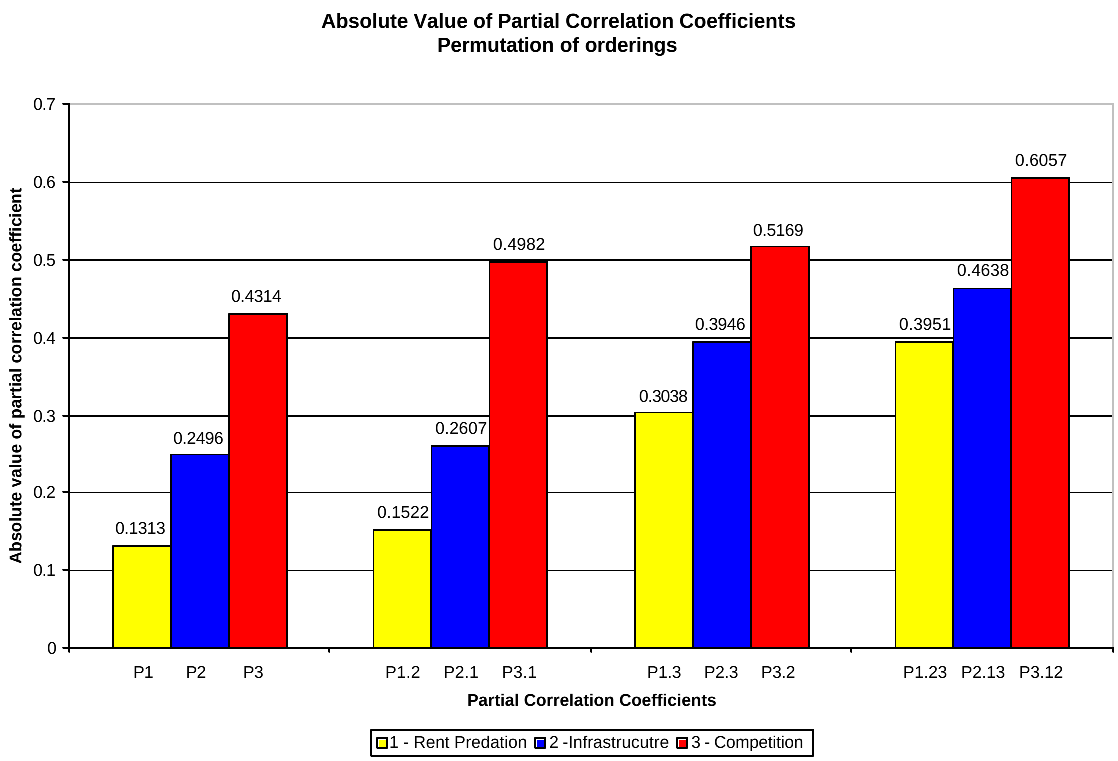
Ordering 4: Partial correlation coefficient between log-TFP and IC Rent Predation holding firm controls, IC Infrastructure, and IC Competition fixed.

There is no reason to believe that one ordering is better than any other, since there is no particular order in which the different investment climate dimensions impact firm performance. So a strategy is needed to deal with the information contained in such a sequence of partial correlation coefficients. A natural and intuitive approach would be to plot the four partial correlation coefficients associated with each one of the three dimensions studied. This would provide a visual representation of how log-TFP and different investment climate dimensions are correlated when different variables are held fixed. To do so, the following notation is used (figure A2.1):

- Let $P1$ denote the partial correlation coefficient between firm performance (P) and investment climate dimension 1, holding firm controls fixed.
- Let $P1.2$ denote the partial correlation coefficient between firm performance (P) and investment climate dimension 1, holding firm controls and investment climate dimension 2 fixed.

- Let $P1.23$ denote the partial correlation coefficient between firm performance (P) and investment climate dimension 1, holding firm controls, investment climate dimension 2, and investment climate dimension 3 fixed.

Figure A2.1



Source: Authors' calculations.

The figure illustrates the perils of looking at partial correlation coefficients without considering alternative orderings in which left-out variables are held fixed. The figures for each investment climate dimension fluctuate as the influence of the other two dimensions is added or removed. More important, the visual representation still seems convoluted and unable to deliver a clear message about which dimension matters the most. If the explanatory power of competition is measured by $P3$ and the explanatory power of infrastructure by $P2.13$, infrastructure would appear to be more powerful—but if $P2$ is used rather than $P2.13$, the opposite would be the case.

To address this issue, Kruskal proposes a way of summarizing the information in the figure. The method involves transforming each set of four partial correlation coefficients into a single number by squaring and averaging the coefficients, forming the following indexes:

Equation A2.1

$$Kruskal\ index\ \ for\ Rent\ \ predation = 0.25[(P1)^2 + (P1.2)^2 + (P1.3)^2 + (P1.23)^2]$$

Equation A2.2

$$Kruskal\ index\ \ for\ Infrastructure = 0.25[(P2)^2 + (P2.1)^2 + (P2.3)^2 + (P2.13)^2]$$

Equation A2.3

$$Kruskal\ index\ \ for\ Competition = 0.25[(P3)^2 + (P3.1)^2 + (P3.2)^2 + (P3.12)^2]$$

It is now possible to provide a ranking of investment climate dimensions by their ability to account for the observed variation in firm-level productivity. Moreover, after normalizing the Kruskal scores, it is also possible to provide a quantitative estimate of how much more variation the leading dimension can account for compared with the others (table A2.1).

Table A2.1 Kruskal Scores of Explained Variation

Investment climate dimension	Average of squared partial correlation coefficients	Normalized score (with rent predation as the base)
Rent predation	0.072201	1
Infrastructure	0.125271	1.735038
Competition	0.267092	3.699295

Source: Authors' calculations.

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