ARE SMALL FIRMS MORE INNOVATIVE IN MODERN INDUSTRIES?

by

Kira Pruglo

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Thesis Supervisor: _____ Professor Hanna Vakhitova

Approved by _____

Head of the KSE Defense Committee, Professor Wolfram Schrettl

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Date _____

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Abstract

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In this study we test the hypothesis that small firm are more likely to invest in R&D in modern industries in Ukraine and other transition countries. We define modern industries group based on OECD 2009 Scoreboard Technology Classification of industries according to R&D intensity adjusting for differences for Ukraine. Two definitions of small firm as the those having less than fifty and less than one hundred employees are applied for robustness check. We use two datasets for Ukraine and one for other transition countries to compare the results across countries. The empirical results did not provide strong evidence of the positive effect of small firm size in modern industries group neither on the probability to invest in R&D nor the amount of R&D investment in Ukraine. Mixed results were obtained for other twenty six transition countries. Small firms operating in modern industry are found to be more likely to invest in R&D in Russia, Poland, Armenia, Czech Republic and Estonia. For the majority of other countries the effect was insignificant but still has an expected positive sign.

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GLOSSARY

Innovative firm. Firm, which has positive R&D expenditures in the current year.

Small firm. Firm, which has less than fifty annual permanent full-time employees.

Chapter 1

INTRODUCTION

In his "Capitalism, Socialism and Democracy" (1942) Schumpeter suggested that scale effect, barriers to entry, and easier access to finance make large firms more innovative, technologically more advanced (Acs and Audretsch, 1988). There is a wide history of research in economics dealing with the issue of innovation and firm size. Primarily the problem refers to the Schumpeter's Hypothesis which is well-known in the theory of technology and innovation.

However, the empirical testing of Schumpeterian hypothesis is mainly inconclusive and results differ a lot across studies of innovations and firm size linkages. The possible reason of divergence in results is a failure to account for interindustry characteristics such as technological opportunity of growth, market structure, organizational peculiarities and demand characteristics. Industries with different characteristics are likely to be different by firm size distribution and the extent to which firm size affect innovation activity (Cohen, Levin and Mowery, 1987).

Acs and Audretsch (1988) in their empirical study found that in modern industries the number of innovations introduced in the industry per employee is relatively higher among smaller firms while in traditional industries large firms more often involved in innovative activity. A negative and statistically significant relationship between industry innovative rates and capital intensity, industry concentration and extent of unionization was also found. These findings confirm the importance to account for industry specific characteristics as they may add much information to explanation of innovation activity and firm's size relationship (Acs and Audretch, 1987).

In the period of rapid technological growth the difference in innovative activity performed is significant across industries. For instance, in the OECD countries the most R&D intensive and rapidly growing sectors are accounting and office equipment, IT industry, communications, motor vehicles, medicine, pharmaceutical and chemical industries (Hatzichronoglou, 2008). Schumpeterian hypothesis becomes less evident when uninvestigated advantages or disadvantages of a certain firm size start playing a more distinct role in innovating activities in particular industries (Lerner, 2010).

Ukraine has declared that fostering of innovation activity in industry and services is one of the most important directions of its competitive strategy[1]. Research works of Vakhitova and Pavlenko (2010) and Brown et al. (2010) show a positive effect of firm size on the probability to innovate for Ukrainian firms. However, these studies do not consider variation of innovation activity within the industry due to the characteristics of firms.

There is a need to investigate the influence of firms' size on innovative activity in different industries for Ukraine and for other transition countries as it is crucial to account for disproportional technological development between sectors. In the low technology sectors the influence of firm size on innovative activity may differ from high technology sectors. According to the survey conducted by State Committee of Statistics in 2009 among 7639 firms in processing manufacturing the largest number of enterprises which use at least three advanced manufacturing technologies operate in sector of office supplies, accounting and computing machinery production (25% of enterprises in industry), radio, TV and communications equipment (12,9%), production of other transport equipment (12,0%), medical and optical tools (11,5%), tobacco, coke production, and nuclear fuel (11,1%). The largest

[1] State Agency of Ukraine for investment and development, http://in.gov.ua

share of enterprises using "young" technology (less than 5 age old) is in office equipment production (46,2% of enterprises in industry) while the oldest technologies are used in coke production, refined petroleum products, metal products, and other non-metallic mineral products[2].

These technological differences across Ukrainian industries raise the question we want to address: how firm size affects innovative activity conditioning on industry characteristics (modern or traditional with respect to technological advances). We will test the following hypothesis: small firms in modern industries have higher innovation advantages, while large firms are more innovative in traditional industries.

The thesis is organized as follows. Section 2 represents the theoretical and empirical background. Section 3 discusses the methodology which we use in the empirical estimation. Section 4 describes the data used in the estimation. Section 5 shows the results of the analysis and Section 6 summarizes the most important findings.

[2] State Committee of Statistics,
http://www.ukrstat.gov.ua/operativ/operativ2008/ibd/obstej.htm

Chapter 2

LITERATURE REVIEW

In this section we start with the analysis of the earlier findings on relationship between innovations and firm size. Then we point out the main issues in the modern research on the topic and explain why the industry-level analysis is needed. Further we briefly describe the literature which exists for Ukraine and summarize the basic arguments at the end.

Schumpeter's hypothesis is a traditional starting point in the theory of the size-innovation connection. In particular, this hypothesis states that large firms are more likely to innovate. There are many arguments which explain sources of this large firm advantage. First, R&D costs needed to produce innovation are typically high, which limits small firm opportunities to finance innovation from their profit. This argument is particularly pronounced given that large firms are also less financially constrained in other respects compared to small firms. Second, scale economies in the production of innovations provide better opportunities for large firms. Third, innovation activities are risky. Large investment may not lead to a success. Diversification strategy allows large firms to develop several innovation projects, therefore spreading the risk of failure.

The second part of hypothesis emphasizes the role of market structure for innovations. On one hand, firms with greater market power accumulate more profit and thus are better able to finance R&D from own sources and are better able to earmark the profits from previous innovation projects for new projects. On the other hand, highly monopolistic market, high market share and low competition in the sector may lead to stagnation in technological growth and innovation activity in the long run. Moreover,

there are other problems with large scale of production, such as decreasing returns to scale of innovation and organizational problems associated with bureaucracy in decision making process, difficulties with monitoring and control in a large firm (Symeonidis, 1996).

Obviously, there is a link between firm size and innovation. However, there is no consensus in the literature whether large firms are more innovative compared to small firms. First group of studies consists of earlier findings, which were focused on testing the Schumpeter's hypothesis and came to the conclusion that industry analysis is needed. Second group of studies consists of more recent literature which primarily focuses on the extent and reasons for such dependency between firm size and ability to produce innovation.

Some evidence of the positive relationship between firm size and innovation input measured by R&D intensity was found by Soete (1979). He found that in certain industries innovation input is higher for larger firms, while results in other industries were not significant. For the full sample he also found a positive effect of size, but he did not account for industry specific fixed effects which may potentially bias the results.

No support for higher innovation activity among large firms was found by Scherer (1965). R&D employment intensity as a measure of innovation input and number of patent introduced as a measure of innovation output were used. Sales per employee were used as a measure of size. With a firm-level data for large manufacturing firms he estimated two models which related innovation input (R&D intensity) and innovation output (number of patents) to firm size (sales per employee). Estimation was done for the entire sample and for different sectors separately. Results do not support the hypothesis of increasing R&D intensity and larger number of patent obtained among larger firms. The only positive relationship between firm

size and innovation was found for chemical industry. Similar result was also established by Kamien and Schwartz (1982).

Acs and Audretsch (1987, 1988) performed a firm-level study in 247 four-digit SIC industries in manufacturing. They distinguished between large firms (more than 500 employees) and small firms (less than 500 employees). Researchers argued that proper comparison between industries can be made only after standardizing the innovation input for the industry size. To do so they divide innovation input by the number of employees to estimate innovation rate. A general negative relationship between firm size and innovation activity was found. However, the results vary by industry: small firms have higher innovation rates in 156 industries (more modern industries) while large firms have higher innovation rates in 122 industries (more traditional industries). Innovation intensity is not found to be related to firm size in 170 industries. Authors conclude that it is meaningless to search for the general answer what firm size is better for innovation. Symeonidis (1996) raise a more important question: which characteristics of industry give advantage in producing innovation firms of a different size.

Pavitt et al. (1987) provide evidence that a link between the firm size and innovation output is more complex. Their main findings suggest that large firms with employment more than 10000 employees and small firms with employment varying from 100 to 200 employees are more innovation intensive whilst medium-sized and very small firms are less innovation intensive. The dynamic patterns during 1956-1983 show decreasing R&D intensity among firms with more than 500 and less than 1000 employees and increasing R&D intensity among firms with less than 500 employees (Symeonidis, 1996). Although we can conclude that small firms as well as the largest firms are the most innovation intensive during this period, Pavitt and co-authors stress the significance of industry differences (Pavitt et. al, 1987). It was established that small firms are more innovative in machinery,

instruments and construction; large firms are more innovative in such industries as chemicals, metals, aerospace, and food production. These findings refer to technological capability of industry to innovate with respect to firm size and would be considered in our research.

One of the main reasons for different conclusions in the literature is the industry specific factors, which stimulate enterprises of different sizes. These factors are technological opportunity of growth, demand characteristics, differences in diversification across industries and "appropriability conditions", the extent to which firms are financially constrained and how persistent innovations are across different industries (Symeonidis, 1996). Below we will describe each of these factors separately.

Pavitt (1984) and Pavitt et al. (1987) draw attention to the sectoral differences in technological aspects and demand characteristics, comparing innovations driven by technological advances and consumer preferences. Technological advancement is associated with process innovations and characterized by high market concentration. Innovations driven by demand characteristics relate to product innovations. In sectors where demand-driven innovations prevail the market concentration tends to be lower and smaller firms are likely to operate. We are going to control for these factors in this study.

Appropriability conditions refer to the hypothesis that firms in more concentrated sectors are more innovative (R&D intensive) as it is easier for such firms to earmark the returns from previous innovation projects and they are more likely to innovate in the future. In this respect Symeonidis (1996) stresses the importance of intellectual property rights conditioning for the link between market share and the size of the firm. The protection system increases the probability of innovation among small firms through intellectual property rights protection and patents.

The issue of diversification in explaining firm's innovativeness corresponds to the fact that large firms get advantages performing a larger number of innovative projects than smaller firms. These advantages for large firms come in the form of risk diversification, increasing probability to discover other innovations (not just the one the research project was aimed for) and knowledge transfer between the projects they are involved in (Henderson and Cockburn, 1993). The industry analysis shows different results for new and old industries, product and process innovations. Aron and Lazear (1990) find that small firms in new industry are more effective in introducing innovative product due to diversified strategy. A specific study in the software industry by Prusa and Schmitz (1994) reveals that small and young firms are more efficient in new product introduction, while large and older firms are likely to be more efficient in quality improving of products and developing the variety of existing product (Lerner, 2010).

The next issue which is crucial in investigation of innovation and firm size relationship is the extent to which firm faces financial constraints. It seems reasonable that small firms are more restricted in the financial resources for investment including innovative investments. Different proxies for firm financial resources constraints are used in empirical studies: liquidity coefficients (Grabowski, 1968), cash flow coefficients (Himmelberg and Petersen, 1994), credit-rating index (Czarnitzki, 2005), firm's own claim of facing the financial constraint (Savignac, 2006). The results show that it is relatively easier and less costly for large firms to obtain financing. Large firms may also be constrained in their financial resources but to the less extent than smaller ones. Shortage of financial resources for investing in innovation depends on the industry in which firm is operating (Symeonidis, 1996).

The latter problem is highly related to the sunk-cost of R&D in particular industry. For example, in aircraft industry the sunk-cost of R&D projects

may be very considerable even for a large firm. At the same time R&D sunk-cost in the software industry may be quite low even for a small or medium-sized firm. This is an additional argument to separate industries when analyzing relationship between innovations and firm size.

The last but not the least issue in the industry analysis of innovation and firm size is the issue of innovation persistence meaning the ability of firms to carry on the innovation activity (persistence in innovation inputs) to obtain innovation output in the next period. Persistence of innovation is driven by three main factors: "success breeds success", increasing returns to innovations and sunk-cost of R&D (Peters, 2005). "Success breeds success" refers to higher likelihood of introducing innovation in the next period due to higher technological capability after introducing innovations in the current period. Second factor captures the effect of accumulating human capital in the previous period on knowledge stock rising in the next periods which increases the probability to innovate in the future (Cohen and Levinthal, 1990). Sunk-cost of R&D can be seen as barriers to entry and exit, because firms incur start-up investment when it involves in innovation process. Also sunk-cost of R&D investments prevent firms from exit because if a firm decides to invest in R&D next time it will have to spend these costs again. These factors are highly related to the characteristics of the particular firm like size, market power, availability of financial resources. Specifically, larger firms tend to exhibit relatively higher innovation persistence than smaller firms. Besides, the persistence is more stable in high-technology group of industries than in low-technology group of industries (Peters, 2005).

Empirical findings suggest the permanent nature of innovation is significant. Substantial innovation persistence was found in German firms (Peters, 2005). Huergo and Moreno (2010) establish the persistence of innovative activity in Spanish manufacturing and emphasize the strong impact of

innovation persistence on the long run productivity growth. A similar result for Ukrainian manufacturing firms was found by Vakhitova and Pavlenko (2010). At the same time, no significant innovation persistence was found for Dutch manufacturing firms (Raymond et al., 2006). None of this studies link innovation persistence in industries to the firm size impact on innovating activities in certain industries.

Our research is motivated by the lack of industry analysis of firm size-innovation relationship which deals with issues mentioned above for firms in Ukraine and other transition countries. The relationship between innovation input, innovation output and productivity is investigated by Vakhitova and Pavlenko (2010) using CDM model and considering the notion of innovation persistence. In their study the hypothesis of persistence such as "success breeds success" was observed for Ukrainian firms. Showing the characteristics of the sample they conclude that innovative firms are larger, have higher sales per employee. Modeling the probability to come up with innovation they establish an increasing probability with respect to the firm size (Vakhitova and Pavlenko, 2010). These findings may be seen as a confirmation of Schumpeter's hypothesis. At the same time as the existing literature suggests that specific industry characteristics can affect innovation-size relationship. Recently Brown et al. (2010) analyzed the impact of the total capital investment into non-technological investment expenditures, R&D expenditures, and IT expenditures as measures of innovation on the productivity. With a large panel data of Ukrainian firms for a time period 2000-2007 they distinguish between different ownership types, types of investment and timing of firm's existence (new or old firm), taking into account industry fixed effects. However, this study as well as previous research for Ukraine does not consider variation in innovation activity and firms' characteristics within the specific industry. For example, firms may operate in capital or labor intensive industry, which may affect differently decision to invest into

innovation project. Concentrated versus non-concentrated industry characteristic may result in substantial differences between small and large firms in the innovation activity (Brown et al., 2010).

Summarizing we may conclude that previous studies provide evidence for a relationship between firm size and innovation activity, but results vary both in terms of direction and power of significance. To the great extent this variation may be explained by the operation in the specific industry environment. The most power in explaining different innovative outcomes for large and small firms should be given to technological advances and possibility of growth in the industry, the degree of concentration, capital and labor intensity, the opportunity to implement a diversification strategy and demand characteristics for industry products. The firm specific characteristics we control for in this study include access to financial recourses, market share of the firm in the industry, innovation persistence, ownership structure, and human capital.

Chapter 3

METHODOLOGY

We begin our analysis with the Cobb-Douglas production function of a neoclassical type:

$$Q_i = A_{it} L_{it}^{\theta_1} K_{it}^{\theta_2} M_{it}^{\theta_3} \quad (1)$$

where the output produced by firm *i* (Q_i) depends on labor (*Li*), capital (*Ki*), materials(*Mi*) used in production. A_{it} is a total factor productivity and it depends on R&D stock:

$$A_{it} = W_{it} R\&D_{it}^{\theta_0} \quad (2)$$

where $R\&D_{it}^{\theta_0}$ - is a R&D stock and W_{it} represents all other factors which affect total factor productivity of firm *i*.

Substituting (2) into (1) and taking logs:

$$\ln Q_{it} = \ln W_{it} + \theta_0 \ \ln R\&D_{it} + \theta_1 \ln L_{it} + \theta_2 \ln K_{it} + \theta_3 \ln M_{it} \quad (3)$$

The estimates of θ_0, θ_1, θ_2 and θ_3 measure elasticities of output with respect to R&D and corresponding production inputs.

However, the major drawback of that model was pointed out by Pakes and Griliches (1984). The model focuses on the relationship between R&D investment (innovation input) and firm's output while it is innovation

output which is the factor driving productivity changes. The methodology applied by Pakes and Griliches addresses these drawbacks with three equation model that consists of innovation input, innovation output and productivity equations. However, in their model only innovating firms are considered. This fact leads to selection bias (Heshmati, 2006). Crépon et al. (1998) developed another model (referred in the literature as CDM model) which takes care of this selectivity bias. It consists of four equations which estimate the probability to innovate and amount of innovative input, innovation output equation and productivity equation. We focused on the probability to invest in innovations and the amount of spending depending on firm size and sector at which the firm operates. Thus, we will use the first two equations of the CDM model. These equations are specified as follows:

$$Inn\_Decision = \alpha_{0i} + \alpha_{1i} small + \alpha_{2i} smallmodern + \\ + \alpha_{3i} X_{1i} + \alpha_{4i} INDS + e_{1i} \quad (4)$$

$$In\_Input = \beta_{0i} + \beta_{1i} small + \beta_{2i} smallmodern + \\ + \beta_{3i} X_{1i} + \beta_{4i} INDS + Mills\_Ratio + e_{2i} \quad (5)$$

Equations (4) and (5) estimate the probability of firm being involved in innovative activity and amount of innovative expenditure (inputs) respectively using Heckman two-stage procedure and address R&D non-reporting selectivity problem. Firms are selected conditional on some threshold under which they report R&D. The estimation of the model only for firms reporting R&D expenditures will lead to upward bias. The fact of underreporting the R&D expenditure under certain level is mentioned by Crépon et al. (1998) and Griffith et. al.(2006). It was previously observed for Ukraine (Vakhitova and Pavlenko, 2010) as well. Vakhitova and Pavlenko note that some firms which do not report innovation expenditure in the previous period come up with innovative product or process next period.

Using this approach we estimate the model for the whole sample, not just for innovative firms taking into account the discussed selection.

Though we employ the CDM model that Vakhitova and Pavlenko (2010) used for estimation of innovation impact on productivity the object of this research is quite different. Basically it aims at estimating the innovation-size relationship focusing on within group of industries (modern and traditional) difference. CDM model allows to estimate the effect of small firm size in modern group of industries on the stage of decision to invest in innovation project. Moreover, BEEPS data allows incorporate into our analysis the impact of financial constraints, appropriability conditions and organizational characteristics on innovation in specific group of industries.

Next I describe the details of variables' construction. The dependent variable in the first equation is a probability of investment in innovation (Inn_Decision), which is a binary variable equals to one if the firm is involved in R&D and zero otherwise. As a dependent variable in the second equation (In_input) innovation input we will use the R&D intensity.

The explanatory variable of interest is an indicator for a firm being small and its interaction with an indicator for a modern industry. Firm is defined as small if the average annual number of permanent full-time employees is less or equal 50 (article 63 of Economic Code). INDS is set of industry dummies. Smallmodern is the interaction term indicating the small size is operating in the modern industry. The expected sign for an interaction of the small firm dummy with the modern industry dummy is positive.

Vector X_1 includes other controls such as the presence of financial constraints, a share of the skilled labor, a dummy for a firm with more than five competitors, a dummy for a firm facing informal competition, a dummy for a firm which mainly operates at the international market, a dummy for a

newly established firms and for a dummy for getting a subsidy, which impacts the probability of investing in R&D. The second equation in addition contains Mills Ratio to correct for selection.

A dummy variable accounting for the extent of financial constraints is equal to one if firm claims that access to finance is very severe and is a major obstacle to the current operations. This variable captures the extent of availability of loans, interest rates and collateral requirements. Additional variable which controls for availability of resources is a dummy variable subsidy which is equal to one if firm obtains a government support in a form of subsidy.

Skilled labor share characterizes the share of skilled production workers in the total number of firms' annual permanent full-time employees. Measuring the share of skilled workers only in production may introduce bias towards small firms because they usually do not have an R&D department as large firms tends to have more skilled workers in the R&D department. Unfortunately, this is the only available measure in the data.

The dummy variable for more than five competitors captures the effect of competition and market concentration in the industry on the innovation activity. International market dummy variable which is equal to one if firm declares international market as its main market and zero otherwise. This variable incorporates the impact of international competition into our analysis.

To proxy for intellectual property protection on the innovative activity we constructed a dummy variable which is equal to one if firm claims that it faces the competition from unregistered "informal" firms and zero otherwise. We expect a negative impact of informal competition.

The full list of variables and their definitions may be found in Table A1 of Appendix A.

Chapter 4

DATA DESCRIPTION

This study relies upon the Ukrainian firm-level data from the EBRD-World Bank Business Environment and Enterprise Performance Survey (BEEPS) 2009[3]. The original number of observation in the cross-section was 731. Focusing on the manufacturing sector we exclude such service sectors as construction, retail, hotel business, wholesale, restaurants, transport, communication, storage and IT (NACE 2-digit codes:45, 50-52, 55, 60-64, 72). In addition I exclude those observations for which the data on the number of employees (4 observations) and the total annual firm's sales (152 observations) were missed. The resulting sample consists of 380 firms.

BEEPS provides information on R&D expenditures, whether product and process innovations introduced during a year, annual sales, percent of annual sales from new product (process), upgraded technology, total number of permanent full-time employees, number of skilled employees, access to finance, number of competitors, net book value of assets. Also survey includes information on an industry code, location, ownership structure and other information.

We base the division of industries into modern and traditional on the OECD 2009 Scoreboard technology classification[4] using technology advancement as an identification factor for "modern" and "traditional" industry. This classification divides manufacturing industries into four groups according to their R&D intensity (R&D expenditures divided by

[3] http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/ECAEXT/EXTECAREGTOPANTCOR/0,,contentMDK:21303980~pagePK:34004173~piPK:34003707~theSitePK:704666,00.html

[4] http://www.oecd.org/document/10/0,3343,en_2649_33703_39493962_1_1_1_1,00.html

value added and R&D expenditures divided by output): high technology, medium-high technology, medium-low technology and low technology. For our purposes a high technology group is merged with medium-technology group into one modern industries' group. NACE codes for modern group of industries are 24, 29-35, 35.3. It includes aircraft, pharmaceuticals, office, accounting and computing machinery, radio, TV and communications equipment, medical and optical instruments, electric machinery and apparatus, chemicals, railroad and transport equipment, machinery and equipment. Traditional ("old") group consists of medium-low and low-technology group according to the OECD classification. Therefore, building and repairing of ships, rubber and plastic products, coke, refined petroleum products and nuclear fuel, other non-metallic mineral products, basic metals, fabricated metal products, wood, pulp, paper products, printing and publishing, food products, beverages and tobacco, textile products belong to less technologically advanced traditional group of industries. NACE 2-digit codes for traditional group of industries are 15-23, 25-28, 36-37, 351, 36-37.

Considering possible differences in technology we adjusted the OECD classification to Ukrainian industries' peculiarities. For this purpose we follow the Methodology of identification high-technological Ukrainian manufacturing enterprises, which was developed by the State Institute of Complex Techno-economic Research, Ministry of Industrial Policy of Ukraine and the State Statistics Committee of Ukraine.[5] At most aspects Ukrainian data is consistent with OECD classification. However, the differences in technological development are significant for some industries. Specifically, tobacco (16) and food and beverages (15) are redefined as modern industries based on the fact that according to the State Committee of Ukraine the majority of enterprises which use the most advanced

[5] State Committee of Statistics,
http://www.ukrstat.gov.ua/operativ/operativ2008/ibd/obstej.htm

technology (less than 5 years) work in these particular industries in Ukraine. Therefore, the final classification and distribution of firms are available in the Table A2 in the Appendix A. After we eliminated the missing observations the resulting industry breakdown by modern and traditional is given in the Table 1. Summary statistics for the full sample is represented in the Table 2.

Table 1. Industries breakdown by modern and traditional group, BEEPS

NACE 2-digit code	Industry	% of total	Observations
Modern		**BEEPS, 2009**	
15	Food & Beverages	21.32	81
24	Chemicals	1.84	7
29	Machinery	26.05	99
31	Office, Accounting & Computing Machinery	1.58	6
34	Motor Vehicles, Trailers & Semi-trailers	0.26	1
All modern industries		51.05	194
Traditional			
17	Textile	3.42	13
18	Wearing Apparel, Dressing and Dyeing of Fur	28.95	110
19	Leather, Handbags, Footwear	0.26	1
20	Wood and Wood Products	2.63	10
21	Paper & Paper Products	0.26	1
22	Printing	1.58	6
23	Coke, Refined Petroleum, Nuclear Fuel	0.53	2
25	Rubber & Plastics	0.53	2
26	Other Non-metallic Products	3.68	14
27	Metals	0.53	2
28	Fabricated Metal Products	5.26	20
36	Furniture	1.05	4
37	Recycling	0.26	1
All traditional industries		48.95	186
All modern and traditional industries		100.00	380

Modern industries firms represent 51.05% of the total sample while traditional industries firms make other 48.95%, which illustrates almost equal representation of modern and traditional industries in the sample. The

sample composition by industries is broadly comparable to the national averages as reported by State Statistics Committee of Ukraine.[6] In particular, according to State Statistics Committee of Ukraine reports in 2007 44.4% of Ukrainian firms in population operate in the modern industry group (according to our classification) and 55.6% of firms operate in the traditional industries. Some differences at the industry level are driven by BEEPS sampling procedures. In all medium and large countries two manufacturing sectors are chosen: manufacture of food products and beverages (15) and manufacture of wearing apparel and fur (18). Other industries are selected according to employment, number of firms and value added. The discussion below focuses primarily on the BEEPS data (see Table 1).

The share of firms which operate in food and beverages (21.32%) and machinery (26.05) is the highest among the modern industry group both in our sample and in the population though the machinery sector is somewhat overrepresented in our sample. Office, accounting and computing machinery sector is underrepresented in our data. Its share in the population of firms is about 10% and only 1.58% in our sample.

Wearing apparel, dressing and fur dyeing comprise the largest share of traditional industry group in our data (28.95%) (it is overrepresented in the sample as compared to the State Statistics Committee of Ukraine reports (2007).

The average firm in BEEPS employs about 147 workers. However, there is a huge variation in the firm size from 4 to 5000 employees. There is 61% of small firms and 39% firms are large. According to the State Statistics Committee of Ukraine there were 81.2 % of small firms with less than fifty

[6] State Statistical Committee of Ukraine. 2008. Statistical Yearbook of Ukraine 2007. Kyiv: Derzhkomstat.

employees in the manufacturing registered at the end of 2007 year.[7] On average 52% of employees in the sample are skilled production workers. About 7% of firms have been established in 2005-2007.

Table 2. Summary statistics for the BEEPS sample

Variable	Mean	Std. Dev	Min	Max
Modern industry	0.51	0.50	0.00	1.00
Traditional industry	0.49	0.50	0.00	1.00
Innovation Decision	0.14	0.35	0.00	1.00
Small50	0.61	0.49	0.00	1.00
Small100	0.72	0.45	0.00	1.00
Firm size	146.57	400.21	4.00	5000.00
R&D intensity	0.01	0.03	0.00	0.36
Product innovation	0.60	0.49	0.00	1.00
Process innovation	0.77	0.42	0.00	1.00
Share of skilled employees	0.52	0.33	0.00	1.00
More than 5 competitors	0.44	0.50	0.00	1.00
International market	0.10	0.30	0.00	1.00
Informal competition	0.37	0.48	0.00	1.00
Subsidy	0.03	0.18	0.00	1.00
Foreign	0.06	0.24	0.00	1.00
Financial constraints	0.41	0.49	0.00	1.00
Newly established firms during 2005 - 2007	0.07	0.26	0.00	1.00

There is a very high share of firms with product and process innovations introduced during 2007-2009 compared to population. 60% of firms in the sample introduced new product and 77% of firms upgraded the existing technology. According to the State Statistics Committee of Ukraine there are approximately 10% of manufacturing firms introduced at least one product or process innovation during 2007 year. This drastic difference is explained by a very broad definition of product and process innovation in the questionnaire. A new product or process here seems to mean "new to

[7] State Statistical Committee of Ukraine. 2008. Statistical Yearbook of Ukraine 2007. Kyiv: Derzhkomstat.

the firm" while the State Statistics Committee of Ukraine defines innovations as "new to the market".

Considering the extent of protection of innovations (appropriability conditions) we observe that 10% of firms in the sample are facing international competition, 37% of firms are facing the competition from informal (unregistered) firms and 44% of firms operate in the market with more than five competitors. These facts show a low extent of protection of new inventions and can explain a low level of patenting and licensing in Ukraine. For 41% of firm's financial constraints (availability, interest rates, and collateral requirements) are very severe and major obstacles to the operational activity. About 3% of firms have got government support in a form of subsidy.

In order to analyze the difference in modern and traditional group between innovative and non-innovative firms we calculate summary statistics by these groups (Table 3 below). There are different definitions of innovative firm in the literature. The most common classification considers firm to be innovative if it introduced at least one product or process innovation during the year. However, as in BEEPS the percent of firms which introduced product or process innovation is remarkably high the above-mentioned definition will misrepresent the number of innovative firms. The second approach in the literature defines a firm as innovative if it had positive R&D expenditure. However, this particular definition has a number of drawbacks. The main drawback is that firms (especially small firms) tend to underreport the amount of R&D expenditures or not report at all. For instance, the incentive to report the R&D expenditures in particular period may depend on possible tax credit policies and R&D accounting costs. In transition counties R&D expenditures underreporting is even more pronounced (Chudnovsky et.al, 2006). After careful consideration of the data

particularities the second definition is adopted in this study and a firm is considered innovative if it had positive R&D expenditure in the 2007.

The data in the Table 3 below reveals that R&D intensity is a bit higher while labor productivity is lower in traditional industries compared to modern industries. This may indicate traditional firms' attempts to restore their competitiveness by investing into R&D.

Table 3. Summary statistics for innovative and non-innovative firms within modern and traditional industries, BEEPS

Variable	Modern		Traditional	
	innovative	non-innovative	innovative	non-innovative
RD intensity	0.04	0.00	0.07	0.00
Firm size	228.69	183.33	181.88	90.89
Small firms (<=50 employees)	0.44	0.59	0.44	0.68
Product innovations	0.95	0.54	0.94	0.54
Process innovations	0.97	0.71	0.94	0.76
Share of skilled employees	0.52	0.49	0.71	0.52
Newly established firms during 2005 – 2007	0.03	0.06	0.00	0.10
More than 5 competitors	0.51	0.39	0.56	0.46
International market	0.21	0.09	0.25	0.07
Informal competition	0.28	0.28	0.63	0.44
Subsidy	0.03	0.04	0.06	0.02
Foreign owned	0.05	0.06	0.06	0.06
Financial constraints	0.49	0.44	0.44	0.37

Turning to the modern subgroup of the sample, the majority (56%) of innovative firms are large while the majority of non-innovative firms are small (59%). The difference in means for innovative and non-innovative firms is significant at 10% significance level (see Table A3 in Appendix A). The average firm size is also appeared to be higher among innovative firms and is about 229 permanent employees. There are similar patterns for the

traditional industries. Here as well innovative firms are more likely to be large (56%) while there are more small firms among non-innovative firms (68%). The difference in means for innovative and non-innovative firms is significant at 10% significance level. However, contrary to our hypothesis, firms in traditional industries on average employ fewer workers than firms in modern industries. This is true both for innovative and non-innovative companies. In particular, on average there are 182 fulltime employees in innovative firms in traditional industries and 229 persons in modern ones. An average non-innovative traditional firm employs 91 full-times workers which is about two times smaller than the firm size in non-innovative modern firms.[8]

In this respect the data statistics contradicts to the original hypothesis we made in two dimensions. First, as can be seen from the summary statistics on average the innovative firms are larger than non-innovative in both groups of industries. Second, both innovative and non-innovative firms in modern industries are larger compared to traditional, which is even more interesting. Based on such statistics we decided to compare the firm's size distribution across modern and traditional industries on the alternative dataset in order to find out if there is a bias due to sampling peculiarities. In addition, it would be useful to analyze the same statistics for other countries in BEEPS in order to distinguish a particular country effects on size distribution across sectors from the real effects of sector-size on innovations.

Innovative firms in the modern industries operate in more competitive environment compare to non-innovative. Among former 51% have more than five competitors compared to 39% of non-innovative firms. Higher

[8] Firm size difference is not statistically significant except for innovative and non-innovative firms in traditional industries. But this outcome may be driven by a small sample size. See formal test in means in Tables A3-A5 of the Appendix A.

proportion of innovative firms is operating internationally. Among them 21% define foreign market as their main market compared to 9% among non-innovative firms. At the same time the share of firms in modern industries that face an informal competition with unregistered companies is the same for innovating and non-innovative firms. Importantly, in modern industry innovative firms are less capital intensive than non-innovative.

The picture is very similar in traditional industries. In particular, 56% of innovative and 46% of non-innovative firms mention more than five competitors. Innovators also face more international competition. In fact, the gap is even larger here. Share of innovative firms who define their main market as international increase to 25 % while the share of non-innovative firms declines to 7%. In contract to modern industries, much larger proportion of traditional firms faces informal competition from unregistered firms, in particular among innovative firms (63% compared to 44% of non-innovative firms).

The second dataset was previously used by Vakhitova and Pavlenko (2010), hereafter VP dataset, to investigate the effect of innovation on productivity. The focus of the VP dataset is on manufacturing sector as well as in BEEPS (NACE codes 10 – 41). The sample is a random draw from the large dataset of all Ukrainian firms originally collected by the State Statistics Committee of Ukraine. VP sample consists of 792 manufacturing firms.[9] The data covers 2004–2006 period. Summary statistics for VP dataset is given in Table A6 in Appendix A.

Vakhitova and Pavlenko (2010) used an alternative definition of innovative firm as a firm which introduces at least one product or process innovation. As we described above we can not rely on such classification due to a very

[9] See Vakhitova and Pavlenko (2010) for details.

broad definition of product and process innovation in the BEEPS. Therefore, to make an analysis of two datasets comparable we apply the same definition to both sets, i.e. firm is innovative if it has positive R&D expenditures in the current year.

Comparing average firm size for innovative and non-innovative companies across datasets in the two industry groups we clearly see a similar pattern (Table 4 below). The innovative firms are larger in both groups of industries in both datasets. This time the difference in means is significant at 1% (see Table A7, A8 in Appendix A). On contrast, the difference in means in the BEEPS sample is not significant in modern industries, which may be a result of small sample size. In the VP dataset innovative firms are three times larger than non-innovative in the modern industries and nine times larger in the traditional industries.

The difference in size among non-innovative firms is considerably lower but still present. Specifically, non-innovative modern firms in the VP dataset are two times larger than corresponding firms in BEEPS in the modern group and three times larger in the traditional group. This implies that BEEPS oversamples small firms as compared to VP dataset.

Table 4. Average employment in innovative and non-innovative firms within modern and traditional groups, BEEPS and VP dataset

Data source	**Modern**		**Traditional**	
	Innovative	**Non-innovative**	**Innovative**	**Non-innovative**
BEEPS Ukraine	228.69	183.33	181.88*	90.89*
VP dataset	929.62***	335.25***	1652.44***	270.98***

* significant at 10%; ** significant at 5%; *** significant at 1%

The number of firms, which have less than fifty employees and defined as small, is much lower in the VP dataset and comprises only 13 %. In BEEPS

it is about 61%. Based on that, we considered an alternative definition of a small firm as a firm which has no more than a hundred employees for the robustness check.

The question arises whether such trends in firm size distribution are specific for Ukraine or this is in line with other countries' innovation-size patterns across modern and traditional industries. Using a BEEPS survey for 27 countries we summarize the size distribution of innovative and non-innovative firms across two groups of industries in the Table 5. Detailed summary statistics for transition countries is available in the Appendix B.

Most importantly in terms of research question, on average innovative firms are larger than non-innovative companies, both in modern and traditional groups. The size of innovative firms in modern group is relatively higher than in traditional group in the majority of countries (this difference is significant at 1% significance level). In the same time we can easily see that for Albania, Tajikistan, Turkey, Russia, Romania, Moldova, Macedonia and Croatia the innovative firms in modern industries is relatively smaller than in traditional industries.

The summary statistics for different datasets for Ukraine as well as for the majority of other transition countries shows a contradiction to the hypothesis that small firms are more innovative in the modern industries and large firms are more innovative in the traditional sectors. However, these statistics may be driven by correlation with other factors. The next section tests formally whether small firms in modern group are more likely to invest in R&D and whether they invest more intensively.

Table 5. Firm size statistics for innovative and non-innovative firms within modern and traditional industries by counties

Countries	Modern		Traditional	
	Innovative	Non-innovative	Innovative	Non-innovative
Albania	137.29	48.22	300.42	64.3
Belarus	375.81	236.79	319.44	157.65
Georgia	303.65	64.51	101.91	58.65
Tajikistan	228.19	90.55	233.14	138.96
Turkey	175.28	53.03	257.36	140.6
Uzbekistan	762.37	154.14	525.3	95.76
Russia	325.29	212.07	353.95	148.38
Poland	158.66	49.44	139.78	31.52
Romania	257.67	86.3	317.92	98.47
Serbia	323.35	135.61	250	119.48
Kazakhstan	244.64	93.94	156.48	58.84
Moldova	222.33	89.36	301.28	107.29
Bosnia	137.68	107.7	85.33	118.49
Azerbaijan	135.78	132.53	120	76.7
Makedonia	72.83	49.94	180.42	122.37
Armenia	88.8	49.6	88.95	62.71
Kyrgyz	184.06	115.88	178.47	113.08
Estonia	250	114.37	197.97	54.84
Czech Republic	362	124.96	293.52	110.54
Hungary	370.79	109.95	318.63	101.04
Latvia	235.89	154.54	233.1	86.66
Lithuania	237.63	80.74	149.17	81.2
Slovakia	443	176.11	293.28	318.65
Slovenia	259.06	86.72	208.02	84.38
Bulgaria	238.15	94.51	148.8	85.04
Croatia	160	141.02	434.61	81.27
Montenegro	84.5	29.7	50	47.55

Chapter 5

EMPIRICAL RESULTS

In this section we present the empirical results starting from selection equation and innovation input equations for the first dataset (BEEPS) defining small firm as a firm with less than fifty employees. Then we estimate the model on the VP dataset using an alternative definition of small firm (a firm with less than one hundred employees) and an alternative specification. At the end we present the estimation results for other transition countries using BEEPS dataset.

5.1 Selection equation, BEEPS dataset

The selection equation estimates the probability of firm to invest in R&D. As can be seen from the Table 6 small firms are less likely to invest in R&D. This result is in line with the Schumpeterian hypothesis. Our results do not confirm the hypothesis of higher probability of small firm in the modern industries to be engaged in R&D activity. The interaction term of dummy for the small firm and dummy for modern industry has positive but insignificant effect on the decision to invest in R&D. Therefore, the results of selection equation indicate that small firms are less likely to invest in R&D irrespectively to the type of industry. These findings do not indicate that there is some advantages for small firms in modern group of industries on the stage of decision whether to invest in innovation or not.

Drawing the attention to market concentration variable, which is proxied by the dummy variable for more than five competitors, we may say that probability of investing in R&D is higher for firms which operate in more competitive environment and less concentrated. Thus, the second part of

Schumpeterian hypothesis of increasing innovative activity with increase in the market share is not confirmed by our estimation.

The firms which declare the international market as their main market are more likely to invest in R&D, which is consistent with other research. This stylized fact was explained by Melitz (2003). Firms, which become more productive after they invest in R&D, start to export after reaching a certain productivity cut-off point (Melitz, 2003, Constantini and Melitz, 2007, Atkenson and Burstein, 2010). Empirically it is established by Loof et. al. (2001) that there is a positive relationship between the probability to invest in R&D and the export intensity in Finland, Norway and Sweden.

We did not find any significant effect of subsidy allocation from government or EU on the decision to invest in R&D. This result is a contradiction to VP findings. They obtained large in magnitude and positive significant result for government support on the likelihood to be engaged in R&D. No significant effect of financial constraints on the probability to innovate was obtained.

The hypothesis of lower incentive to invest in R&D if firm faces an informal competition with unregistered firms (as a measure of appropriability conditions) was not confirmed by our results. There is also no significant effect of the share of skilled labor and newly established firms on the probability to invest in innovation.

There are evidences in the literature that probability to invest in R&D is highly increasing for successful previous innovators. However, we do not have panel data to obtain the lagged variables of innovation output, but we will address this issue using an alternative dataset and specification.

Table 6. Selection equation and innovation input equation, BEEPS

Variables	Selection Equation	Innovation Input Equation
Small1	-0.672*	-0.385
	(0.027)	(0.889)
Small1modern	0.334	0.198
	(0.364)	(0.893)
Informal competition	-0.0509	-0.00761
	(0.803)	(0.980)
More than 5 competitors	0.685**	0.468
	(0.003)	(0.860)
Skilled labor share	0.160	0.0974
	(0.651)	(0.901)
Subsidy	0.252	0.146
	(0.623)	(0.881)
Newly established	-0.662	-0.641
	(0.178)	(0.831)
International market	0.522	0.374
	(0.078)	(0.855)
Financial constraints	0.207	0.136
	(0.260)	(0.873)
Constant	-1.795***	-2.131
	(0.000)	(0.853)
Mills lambda		1.014
		(0.848)
Observations	380	55

Dependent variable in the selection equation: Innovation Decision – probability of investing in R&D. Dependent variable in the innovation input equation: R&D intensity – R&D expenditures divided by total annual sales; small firm – firm with less than 50 employees; *p*-values in parentheses:* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, four industry dummies were included in each equation

5.2 Innovation input equation, BEEPS dataset

The innovation input equation characterizes the influence of firm being small, being small in the modern industries and other control variables on the amount of R&D investment. The estimated equation does not show any significant effect of small firm and small firm in the modern industry. However, the signs are as expected. At the same time the absence of size effect on the amount of R&D investment is a stylized fact. Similar result was established in Cohen and Klepper (1996) and confirmed by other researchers.

Other factors are also insignificant having the expected signs except financial constraints. As we suppose this is mostly due to a small sample size. And another weakness arises because the innovation input equation is includes the same vector of explanatory variables. The conventional CDM models exclude the size variable from the innovation input equation. However, given the purpose of analysis we would like to estimate the effect of firm being small on the amount of R&D invested.

5.3 Selection equation, VP dataset

The selection equation estimated on the VP dataset is shown in the second column of Table 7. There is a negative and significant effect of firm being small on the probability to invest in R&D.

Table 7.Selection equation and innovation input equation, VP dataset

Variables	Selection Equation	Innovation Input Equation
Small100	-0.989**	0.0310
	(0.002)	(0.980)
Small100modern	0.421	0.328
	(0.299)	(0.816)
Human capital	-0.228	4.006
	(0.718)	(0.064)
Government funding	2.134***	2.687**
	(0.000)	(0.003)
Newly established	0.606	0.966
	(0.136)	(0.396)
Downzised	-0.444	3.574**
	(0.270)	(0.003)
CIS countries	0.0387	1.395
	(0.923)	(0.061)
Other countries	-0.234	-0.207
	(0.522)	(0.799)
Market concentration	0.0367	-2.716
	(0.980)	(0.219)
Previous success	1.892***	-
	(0.000)	
Innovation_expenditure_2005	-	1.167*
	-	(0.015)
Process innovation_2005	-	0.769*
	-	(0.039)
Productivity_2005	-	0.405*
		(0.047)
Constant	-1.615***	-4.603***
	(0.000)	(0.000)
Mills ratio		0.156
		(0.677)
Observations	792	121

Dependent variable in the selection equation: Innovation Decision – probability of investing in R&D. Dependent variable in the innovation input equation: R&D intensity – R&D expenditures divided by total annual sales; small firm – firm with less than 100 employees; *p*-values in parentheses:* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; seven industry dummies were included in each equation

The government funding appears to be the most important factor which influences the probability to invest in R&D on this dataset. This is a reasonable result, because government funding increases the financial resources available to the firm. In the BEEPS dataset we did not find a significant effect of subsidies. On the other hand, getting subsidies from the government may lead to an opposite effect, i.e. decreasing incentive to invest in R&D and to introduce new products. Also as discussed in by Vakhitova and Pavlenko (2010) in their specification there is an evidence of persistence in innovation. Using the alternative definition of innovative firm our estimates still indicate a large in magnitude, positive and significant effect of previous success of introduction of new products or processes.

It is interesting that using the BEEPS dataset with comparable definition of small firm (less than 100 employees) we obtain a positive significant effect of strong competition on the probability to innovate (Table C1 in Appendix C). This is contradicting to the Schumpeter's that firms in more concentrated markets are more innovative. Using the VP specification, where market concentration is represented by Herfindahl - Hirshman index, there is no significant effect of market structure and competition on the probability to invest in R&D. This suggests that a direct measure of firm's competitors is a more appropriate indicator of competition and concentration than HH index.

5.4 Innovation input equation, VP dataset

The third column in the Table 7 illustrates the estimates of the innovation input equation on the VP dataset. Small firm dummy variable and the small firm in the modern industry group have no significant effect on the amount of investment in R&D as well as in the BEEPS dataset (Table C1 in the Appendix C). So the effect of particular small firm size in the modern group of industry is not found in the both datasets. This finding confirms the

standard result in the literature that R&D intensity is not affected by the firm size.

There is a large and significant effect of government funding on the amount of innovative investment. Firms, which downsized, on average invest more intensively in R&D to recover the decreased sales. Innovative persistence has a powerful power in explaining the variation in the amount of R&D investment. Last period innovative expenditures, introduced process innovation and productivity have a significant positive effect on the amount of innovative investment. It is a clear illustration of "success breeds success hypothesis" meaning that firms which invest in innovation introduce new technology and have higher productivity in the previous periods invest more in R&D.

5.5 Estimation results for other transition countries

In order to analyze the effect of small firm size in the modern industry group on the innovation activity in other transition countries we estimate the model for twenty six transition countries (Montenegro was excluded due to a very small number of observations) using BEEPS 2009 panel dataset. The specification of the model is the same as the one used for Ukraine on BEEPS dataset. The estimation was done for two definitions of small firm: less than fifty and less than one hundred employees. As the results for innovation input equations appeared to be insignificant, we report the results of estimation only for selection equation in the Tables C2 and C3 of Appendix C.

Table 8 summarizes the main results from selection equation for different countries. The estimates of the effect of small firm are represented in the second column and the estimates of the effect of small firm operating in the modern industry is given in the third column.

The results indicate that for the majority of transition countries the small firms are less likely to be engaged in R&D activity (19 countries). In the majority of counties (21 countries) in the sample there is no significant effect of small firm operating in the modern industry group on the probability to invest in R&D.

It is possible though that low significance is driven by a small sample size. To investigate this issue we checked the magnitude of the *smallmodern* variable for the remaining countries.

Table 8. The effect of small firm size in modern industries on the probability to invest in R&D for transition countries

Country	**Small firm effect**	**Effect of Small*Modern**
Albania	insignificant	insignificant
Belarus	insignificant	insignificant
Georgia	insignificant	insignificant
Tajikistan	negative	insignificant
Turkey	negative	insignificant
Uzbekistan	insignificant	insignificant
Russia	negative	positive
Poland	negative	positive
Romania	negative	insignificant
Serbia	negative	insignificant
Kazakhstan	negative	insignificant
Moldova	negative	insignificant
Bosnia	insignificant	insignificant
Azerbaijan	insignificant	insignificant
Makedonia	insignificant	insignificant
Armenia	negative	positive
Kyrgyz	negative	insignificant
Estonia	negative	positive
Czech Republic	negative	positive
Hungary	negative	insignificant
Latvia	negative	insignificant
Lithuvania	negative	insignificant
Slovakia	negative	insignificant
Slovenia	negative	insignificant
Bulgaria	insignificant	insignificant
Croatia	negative	insignificant

In 13 out of 21 countries the coefficient of the effect of small firm in modern industries is insignificant but has an expected positive sign. In other eight countries the effect is negative and insignificant. Thus, we may conclude that there is weak evidence for insignificance being caused by a small sample size.However, in such countries as Russia, Poland, Armenia, Estonia and Czech Republic the effect of small firm in the modern industry group appeared to be positive (the general effect of firm being small is still negative and significant). This result poses question for further research: why a positive effect of a small firm size in a particular industry group is present in some countries while it is insignificant in other states?

Chapter 6

CONCLUSIONS

This study investigates the advantages of small firms with respect to technological opportunities and advances of industry in which they operate on Ukrainian data and compare the results to other transition countries. The main hypothesis which was investigated is as follows: do small firms in the modern industries invest more in R&D while large firms spend more on R&D in traditional industries.

We looked at two main questions with respect to the hypothesis made. The first one was whether there is a relationship between small firm size in modern sectors and the probability to invest in R&D. The second question is does firm size in modern sectors matter for the amount of R&D invested. We used a first part of CDM model to account for selectivity and endogeneity effects. For the robustness check the estimation was performed on two datasets and applies two definitions of small firms (firms with less than fifty employees and firms with less than one hundred employees) as well as two specifications.

The descriptive statistics reveal unexpected results. In particular, firms in the modern industry group are appeared to be larger than in traditional group. More important, innovative firms are larger than non-innovative in both modern and traditional sectors. The latter are true for both datasets. To ascertain that such firm size distribution within two groups of industries is not the peculiarities of Ukraine only we investigate the firm size statistics for 26 other countries. For majority countries the cross-country means confirm the patterns as well: innovative firms are larger within a modern industry group and relatively smaller within the traditional group of industries.

However, in certain countries innovative firms in modern industries are smaller compared to innovative firms in traditional industries.

The results show that small firms are less likely to invest in R&D. These results are consistent with Schumpeter's hypothesis and a number of previous studies. Our estimations do not confirm the hypothesis that effect of small firm size on the probability to innovate might be different if we look at a particular group of industries based on their technological advance (modern industries) neither on the original dataset nor on the alternative one.

Then we estimated the innovation input equation using two datasets and two specifications. The results shows no significant effect on the decision how much to invest in R&D. The small size effect on the amount of R&D investment within a modern group of industries is not found either.

The estimation results for other transition countries show small firms are significantly more likely to invest in R&D in the modern industries in Russia, Poland, Armenia, Estonia and Czech Republic. At the same time the general effect of small firm size on the likelihood to invest in R&D is negative for abovementioned countries. However, for about half of remaining countries (thirteen countries out of twenty one), the coefficient of small firm size in the modern industry group is insignificant, but it still has an expected positive sign. It may be the evidence of a small sample size problem.

This study is subject to several limitations. The first limitation refers to the sensitivity of the results to small sample problem. For instance, the sample size for Russia and Poland is substantially greater compared to other transition countries used in the estimation. Having a larger comparable in size samples for all countries may clarify whether the difference in results is

driven by sample issues. The second limitation originates from applying the same classification of industries to all countries given the possible country peculiarities in the technological development across industries and the structure of manufacturing by sectors. Unfortunately, a small sample size precluded us from testing firm size effect separately for each industry. The described limitations have to be addressed in the further research.

The difference in results for different countries may be explained by two main groups of factors: the differences in specific characteristic of modern industry group in particular country and the policy interventions which stimulates (or not) either small enterprises in this sector or the sector in whole. For example, the first group of reasons can partly explain the positive significant effect of small firm size in modern industries in Russia. The greatest share in the structure of Russian manufacturing is devoted to oil and gas, metallurgy, which are classified as traditional group of industries. These industries are mostly comprises of large enterprises. Therefore, small firms take innovation advantage in more technologically advanced industries. It may be also due to lower capital and labor costs in modern group of industries or differences in capital-labor intensity.

The second group aggregates the factors concerning with the differences in policy impact on the incentive to invest in innovations by small firms in modern industries. Such policy actions may work through stimulating small firms, small firms in modern industries and just overall support of modern sectors. Especially, tax benefits for small firms and government funding used. The mechanism should be investigated in each country separately. According to OECD Scoreboard 2009, Poland, Czech Republic and Estonia are focused on the developing the high- and medium-technology sectors. There are three running government programs in Czech Republic, which aim to stimulate business R&D expenditures, production of high-technology industries and increase in employment in R&D. Poland in its'

Innovation Strategy for 2007-2013 and Estonia in Estonian Research and Development and Innovation Strategy 2007-2013 declare the priorities for high-technology sectors. As our research showed, in these countries small firms in high- and medium-technology sectors are more likely to invest in R&D. In this respect stimulating small firms in the modern sector may give a valuable payoff for society in the form of increase in productivity in this sector and sustainable economy growth in the long run.

WORKS CITED

Acs, Zoltan J. and David. B. Audretsch. 1987. Innovation, Market Structure, and Firm Size. *The Review of Economics and Statistics* 69: 567-575.

Acs, Zoltan J. and David. B. Audretsch. 1988. Innovation in Large and Small Firms: An Empirical Analysis. *American Economic Review* 78: 678-690.

Acs, Zoltan J. and David. B. Audretsch. 1990. *Innovation and Small Firms.* Cambridge, Mass: MIT Press. Cambridge, Mass.: MIT Press.

Atkenson, Andrew and Ariel T. Burstein. 2010. Innovation, firm dynamics, and international trade. *Journal of Political Economy* 118(3): 433-484.

Brown, David. J., John S. Earle, Vakhitova Hanna, and Vitaliy Zheka. 2010. Innovation, Adoption, Ownership, and Productivity. ESCIRRU Working Paper No. 18, DIW Berlin, German Institute for Economic Research.

Bogutskyy Vladyslav. 2009. Should workers be afraid of innovation? Thesis Paper. KSE MA

Chudnovsky, Daniel, Andres Lopez and German Pupato. 2006. Innovation and Productivity in Developing Countries: A Study of Argentine Manufacturing Firms' Behaviour (1992 – 2001). *Research Policy* 35: 266–288

Cohen, Wesley M. and Daniel A. Levinthal. 1990. Absorptive Capacity: A New Perspective on Learning and Innovation. *Administrative Science Quarterly* 35: 128-152.

Cohen, Wesley M., Richard C. Levin and David C. Mowery. 1987. Firm Size and R & D Intensity: A Re-Examination. *The Journal of Industrial Economics* 35 (June): 543-565

Crépon Bruno, Emmanuel Duguet and Jasques Mairesse. 1998. Research, Innovation, and Productivity: an Econometric Analysis at the Firm Level. Working Paper 6696

Czarnitzki Dirk. 2005. Research and Development in Small and Medium-Sized Enterprises: the Role of Financial Constraints and Public Funding. *Scottish Journal of Political Economy* 53: 335–357

Grabowski Jonathan H. 1968. The Determinants of Industrial Research and Development: A Study of the Chemical, Drug and Petroleum Industries. *Journal of Political Economy* 76: 292-306.

Griffith Rachel, Elena Huergo, Mairesse Jacques and Bettina Peters. 2006. Innovation and Productivity across Four European Countries. National Bureau of Economic Research, Working Paper 12722

Hatzichronoglou Thomas. 2008. Recent Trend in the Internationalization of R&D in the Enterprise Sector. In *OECD Special Session on Globalization Report*

Heshmati, Almas. 2006. A Generilized Knowledge Production Function. Ratio Working Papers 89: The Ratio Institute.

Himmelberg, CharlsP. and Bruce C. Petersen. 1994. R&D and Internal Finance: A Panel Study of Small Firms in High-Tech Industries. *Review of Economics and Statistics*. 76: 38-51

Huergo Elena and Lourdes Moreno. 2010. Does history matter for the relationship between R&D, Innovation and Productivity? MPRA Paper 23611, University Library of Munich

Kamien, Morton I. and Nancy L. Schwartz.1982. *Market Structure and Innovation*. Cambridge: Cambridge University Press.

Lerner, Josh. 2010. Innovation, Entrepreneurship and Financial Market Cycles. OECD Science, Technology and Industry Working Papers: OECD Publishing

Lööf, Hans, Almas Heshmati, Apslund Rita and Naas, Svein-Olav. 2001. Innovation and Performance in Manufacturing Industries: a Comparison of the Nordic Countries. SSE/EFI Working Paper Series in Economics and Finance № 457.

Melitz, Marc J. 2003. The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity. *Econometrica* 71(6): 1695-1725

Wladimir Raymond, Pierre Mohnen, Palm Franz and Sybrand Schim van der Loeff. 2006. Persistence of Innovation in Dutch Manufacturing: Is it Spurious? UNU-MERIT Working paper

Peters Bettina. 2005. Persistence of Innovation: Stylised Facts and Panel Data Evidence. ZEW Discussion Paper 05-81

Pavitt Keith. 1984. Sectoral Patterns of Technical Change: Towards Taxonomy and a Theory, *Research Policy* 13: 343-373

Pavitt, Keith, Michael Robson and Townsend, Joe. 1987. The Size Distribution of Innovating Firms in the UK: 1945-1983. *Journal of Industrial Economics*, 35: 297-316

Peters, Valerie and Guy Gellatly. 2000. Understanding the Innovation Process: Innovation in Dynamic Service Industries. Analytical Studies Branch Research Paper Series 2000127e, Statistics Canada: Analytical Studies Branch

Savignac, Frederique. 2006. The Impact of Financial Constraints on Innovation: Evidence from French Manufacturing. CREST and CES-University of Paris I-Pantheon Sorbonne. Working Paper

Scherer, Frederic M. 1965. Firm Size, Market Structure, Opportunity, and Output of Patented Inventions. *American Economic Review* 55: 1097-1125

Soete, Luc L.G. 1979. Firm Size and Inventive Activity: The Evidence Reconsidered. *European Economic Review* 12: 319-340

Symeonidis, Geordge. 1996. Innovation, Firm size and Market Structure: Shumpeterian Hypotheses and some new theses. OECD Working Paper 161

Vakhitova, Hanna and Tetyana Pavlenko. 2010. Innovation and Productivity: a Firm Level Study of Ukrainian Manufacturing Sector. Discussion Paper Series, (27)

APPENDIX A

Table A1. Definitions of variables

Variable	Definition
Innovation Decision	Dummy variable which is equal to one if firm has a positive R&D expenditures in 2007
Small50	Dummy variable indicating small firm which is equal to one if the number of full-time permanent employees is less or equal than 50
Small100	Dummy variable indicating small firm which is equal to one if the number of full-time permanent employees is less or equal than 100
Firm Size	Number of full-time permanent employees
R&D intensity	R&D expenditures divided by total sales in 2007
Product Innovation	Dummy variable which is equal to one if the firm introduced new product or service since 2007
Process Innovation	Dummy variable which is equal to one if the firm upgraded the existing product line since 2007
Productivity	Sales per employee in 2007 (in log)
Skilled Labor Share	The share of skilled production workers in the total number of permanent full-time employees
More than five competitors	Dummy variable which is equal to one if the firm has more than 5 competitors
International Market	Dummy variable which is equal to one if the firm's most significant market is international
Informal Competition	Dummy variable which is equal to one if the firm compete against unregistered or informal firms
Subsidy	Dummy variable which is equal to one if the firm received subsidy from the national, regional or local governments or European Union sources
Foreign	Dummy variable which is equal to one if the share of foreign ownership is higher than share of domestic ownership and government ownership
Financial Constraints	Dummy variable which is equal to one if the firm declares the access to finance is a major and severe obstacle

Table A2. Industry classification on modern and traditional groups according to technological advances

MODERN		**TRADITIONAL**	
	ISIC REV.3[10]		ISIC REV.3
Manufacture of food products and beverages Manufacture of tobacco products	15	Mining	10-14
Manufacture of tobacco products	16	Manufacture of textiles	17
Manufacture of chemicals and chemical products	24	Manufacture of wearing apparel; dressing and dyeing of fur	18
Manufacture of machinery and equipment n.e.c.	29	Tanning and dressing of leather; manufacture of luggage, and bags, saddlery, harness and footwear	19
Manufacture of office, accounting and computing machinery	30	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	20
Manufacture of electrical machinery and apparatus n.e.c.	31	Manufacture of paper and paper products	21
Manufacture of radio, television and communication equipment and apparatus	32	Publishing, printing and reproduction of recorded media	22
Manufacture of medical, precision and optical instruments, watches and clocks	33	Manufacture of coke, refined petroleum products and nuclear fuel	23
Manufacture of motor vehicles, trailers and semi-trailers	34	Manufacture of rubber and plastics products	25
Manufacture of other transport equipment	35 (excl. 351)	Manufacture of other non-metallic mineral products	26
		Manufacture of basic metals	27
		Manufacture of fabricated metal products, except machinery and equipment	28
		Building and repairing of ships; Building and repairing of pleasure and sporting boats	351
		Manufacture of furniture; manufacturing n.e.c.	36
		Recycling	37

[10] http://unstats.un.org/unsd/cr/registry/regcst.asp?CI=17

Table A3. Summary statistics for innovative and non-innovative sample within modern industries, BEEPS

Variable	Modern		
	non-innovative	innovative	Total
R&D intensity	.	0.04	0.04
Firm size	183.33	228.69	192.45
Small50	0.59*	0.44*	0.56
Product innovations	0.54***	0.95***	0.62
Process innovations	0.71***	0.97***	0.76
Share of skilled employees	0.49	0.52	0.49
Newly established firms during 2005 - 2007	None	None	None
More than 5 competitors	0.39	0.51	0.41
International market	0.09**	0.21**	0.11
Informal competition	0.28	0.28	0.28
Subsidy	0.04	0.03	0.04
Foreign owned	0.06	0.05	0.06
Financial constraints	0.44	0.49	0.45

* significant at 10%; ** significant at 5%; *** significant at 1%

Table A4. Summary statistics for innovative and non-innovative sample within traditional industries, BEEPS

Variable	Traditional		
	non-innovative	innovative	Total
R&D intensity	.	0.07	0.07
Firm size	90.89*	181.88*	98.72
Small50	0.68*	0.44*	0.66
Product innovations	0.54***	0.94***	0.58
Process innovations	0.76	0.94	0.78
Share of skilled employees	0.52**	0.71**	0.54
Newly established firms during 2005 - 2007	0.1	0	0.09
More than 5 competitors	0.46	0.56	0.47
International market	0.07**	0.25**	0.09
Informal competition	0.44	0.63	0.46
Subsidy	0.02	0.06	0.03
Foreign owned	0.06	0.06	0.06
Financial constraints	0.37	0.44	0.38

* significant at 10%; ** significant at 5%; *** significant at 1%

Table A5. Summary statistics for modern and traditional sectors within innovative sample, BEEPS

Variable	Innovative		
	traditional	modern	Total
R&D intensity	0.07	0.04	0.05
Firm size	181.88	228.69	215.07
Small50	0.44	0.44	0.44
Product innovations	0.94	0.95	0.95
Process innovations	0.94	0.97	0.96
Share of skilled employees	0.71***	0.52***	0.58
Newly established firms during 2005 - 2007	0	0.03	0.02
More than 5 competitors	0.56	0.51	0.53
International market	0.25	0.21	0.22
Informal competition	0.63**	0.28**	0.38
Subsidy	0.06	0.03	0.04
Foreign owned	0.06	0.05	0.05
Financial constraints	0.44	0.49	0.47

* significant at 10%; ** significant at 5%; *** significant at 1%

Table A6. Summary statistics for VP sample

Variable	Mean	Std. Dev	Min	Max
Modern industry	0.52	0.50	0.00	1.00
Traditional industry	0.48	0.49	0.00	1.00
Innovation Decision	0.02	0.14	0.00	1.00
Small50	0.13	0.34	0.00	1.00
Small100	0.35	0.48	0.00	1.00
Firm size	339.58	576.25	6.00	5378.00
R&D intensity	0.01	2.11	-6.29	5.29
Product innovation	0.03	0.18	0.00	1.00
Process innovation	0.02	0.14	0.00	1.00
Human Capital	0.19	0.18	0.01	3.13
Market Concentration	0.01	0.04	0.00	1.00
CIS countries market	0.01	0.08	0.00	1.00
Other countries market	0.02	0.13	0.00	1.00
Newly established during 2004-2006	0.03	0.16	0.00	1.00
Government funding	0.01	0.09	0.00	1.00
Downsized during 2004-2006	0.01	0.01	0.00	1.00

Table A7. Summary statistics for innovative and non-innovative sample within modern industries, VP sample

Variable	Modern		
	non-innovative	innovative	Total
Small50	0.13**	0.00**	0.12
Small100	0.30***	0.09***	0.3
Firm size	335.25***	929.62***	351.75
R&D intensity	-0.11***	1.03***	0.04
Product innovation	0.02***	0.85***	0.05
Process innovation	0.02***	0.38***	0.03
Human Capital	0.19	0.21	0.19
Market Concentration	0.01***	0.03***	0.01
CIS countries market	0.01***	0.09***	0.01
Other countries market	0.01	0.03	0.01
Newly established during 2004-2006	0.02	0	0.02
Government funding	0.01***	0.06***	0.01
Downsized during 2004-2006	0.02	0	0.02

significant at 10%; ** significant at 5%; *** significant at 1%

Table A8. Summary statistics for innovative and non-innovative sample within traditional industries for VP sample

Variable	Traditional		
	non-innovative	innovative	Total
Small50	0.15	0	0.14
Small100	0.41**	0.00**	0.41
Firm size	270.98***	1652.44***	283.58
R&D intensity	-0.06	-0.54	-0.1
Product innovation	0.02***	0.56***	0.02
Process innovation	0.01***	0.33***	0.01
Human Capital	0.17	0.17	0.17
Market Concentration	0.01***	0.18***	0.01
CIS countries market	0.00***	0.11***	0.01
Other countries market	0.03***	0.22***	0.03
Newly established during 2004-2006	0.03	0	0.03
Government funding	0.00***	0.11***	0
Downsized during 2004-2006	0.01	0	0.01

significant at 10%; ** significant at 5%; *** significant at 1%

APPENDIX B

Table B. Summary statistics for other transition countries

Variable	Mean	Std. Dev	Min	Max
Albania				
Innovation Decision	0,10	0,31	0,00	1,00
Small50	0,69	0,46	0,00	1,00
Small100	0,82	0,39	0,00	1,00
Firm size	78,75	188,97	2,00	1925,00
R&D intensity	0,03	0,03	0,00	0,13
Product innovation	0,33	0,47	0,00	1,00
Process innovation	0,38	0,49	0,00	1,00
Share of skilled employees	0,45	0,27	0,00	1,00
More than 5 competitors	0,25	0,43	0,00	1,00
International market	0,09	0,28	0,00	1,00
Informal competition	0,26	0,44	0,00	1,00
Subsidy	0,03	0,18	0,00	1,00
Foreign owned	0,16	0,37	0,00	1,00
Financial constraints	0,19	0,39	0,00	1,00
Newly established firms during 2005 - 2007	0,05	0,22	0,00	1,00
Belarus				
Innovation Decision	0,26	0,44	0,00	1,00
Small50	0,60	0,49	0,00	1,00
Small100	0,67	0,47	0,00	1,00
Firm size	210,87	407,36	2,00	2032,00
R&D intensity	0,04	0,07	0,00	0,38
Product innovation	0,72	0,45	0,00	1,00
Process innovation	0,85	0,36	0,00	1,00
Share of skilled employees	0,51	0,29	0,00	1,00
More than 5 competitors	0,16	0,37	0,00	1,00
International market	0,04	0,20	0,00	1,00
Informal competition	0,10	0,30	0,00	1,00
Subsidy	0,08	0,28	0,00	1,00
Foreign owned	0,14	0,35	0,00	1,00
Financial constraints	0,24	0,43	0,00	1,00
Newly established firms during 2005 - 2007	0,00	0,00	0,00	0,00

Table B – Continued

Variable	Mean	Std. Dev	Min	Max
Georgia				
Innovation Decision	0,22	0,42	0,00	1,00
Small50	0,66	0,47	0,00	1,00
Small100	0,81	0,40	0,00	1,00
Firm size	98,24	275,34	4,00	3000,00
R&D intensity	0,04	0,04	0,00	0,20
Product innovation	0,41	0,49	0,00	1,00
Process innovation	0,74	0,44	0,00	1,00
Share of skilled employees	0,51	0,28	0,00	1,00
More than 5 competitors	0,21	0,41	0,00	1,00
International market	0,10	0,31	0,00	1,00
Informal competition	0,29	0,46	0,00	1,00
Subsidy	0,05	0,21	0,00	1,00
Foreign owned	0,07	0,26	0,00	1,00
Financial constraints	0,26	0,44	0,00	1,00
Newly established firms during 2005 - 2007	0,04	0,19	0,00	1,00
Tajikistan				
Innovation Decision	0,20	0,40	0,00	1,00
Small50	0,46	0,50	0,00	1,00
Small100	0,65	0,48	0,00	1,00
Firm size	138,16	218,26	2,00	1350,00
R&D intensity	0,06	0,09	0,00	0,40
Product innovation	0,52	0,50	0,00	1,00
Process innovation	0,69	0,46	0,00	1,00
Share of skilled employees	0,47	0,26	0,00	1,00
More than 5 competitors	0,16	0,37	0,00	1,00
International market	0,06	0,24	0,00	1,00
Informal competition	0,14	0,35	0,00	1,00
Subsidy	0,03	0,16	0,00	1,00
Foreign owned	0,11	0,31	0,00	1,00
Financial constraints	0,19	0,39	0,00	1,00
Newly established firms during 2005 - 2007	0,05	0,22	0,00	1,00
Turkey				
Innovation Decision	0,11	0,31	0,00	1,00
Small50	0,69	0,46	0,00	1,00
Small100	0,80	0,40	0,00	1,00
Firm size	115,24	609,13	20843,00	20843,00
R&D intensity	0,04	0,16	1,84	1,84
Product innovation	0,42	0,49	0,00	1,00
Process innovation	0,63	0,48	0,00	1,00
Share of skilled employees	1,99	8,87	0,00	1,00
More than 5 competitors	0,39	0,49	0,00	1,00

Table B – Continued

Variable	Mean	Std. Dev	Min	Max
International market	0,12	0,33	0,00	1,00
Informal competition	0,52	0,50	0,00	1,00
Subsidy	0,05	0,22	0,00	1,00
Foreign owned	0,02	0,14	0,00	1,00
Financial constraints	0,31	0,46	0,00	1,00
Newly established firms during 2005 - 2007	0,01	0,12	0,00	1,00
Uzbekistan				
Innovation Decision	0,18	0,38	0,00	1,00
Small50	0,57	0,50	0,00	1,00
Small100	0,70	0,46	0,00	1,00
Firm size	226,95	603,88	2,00	6000,00
R&D intensity	0,05	0,09	0,00	0,40
Product innovation	0,34	0,47	0,00	1,00
Process innovation	0,45	0,50	0,00	1,00
Share of skilled employees	0,55	0,23	0,00	1,00
More than 5 competitors	0,11	0,31	0,00	1,00
International market	0,03	0,16	0,00	1,00
Informal competition	0,15	0,36	0,00	1,00
Subsidy	0,02	0,14	0,00	1,00
Foreign owned	0,19	0,39	0,00	1,00
Financial constraints	0,19	0,39	0,00	1,00
Newly established firms during 2005 - 2007	0,02	0,15	0,00	1,00
Russia				
Innovation Decision	0,29	0,45	0,00	1,00
Small50	0,49	0,50	0,00	1,00
Small100	0,66	0,47	0,00	1,00
Firm size	210,42	577,72	1,00	8500,00
R&D intensity	0,08	0,65	0,00	10,00
Product innovation	0,65	0,48	0,00	1,00
Process innovation	0,81	0,39	0,00	1,00
Share of skilled employees	0,43	0,29	0,00	1,00
More than 5 competitors	0,35	0,48	0,00	1,00
International market	0,02	0,12	0,00	1,00
Informal competition	0,26	0,44	0,00	1,00
Subsidy	0,07	0,25	0,00	1,00
Foreign owned	0,06	0,23	0,00	1,00
Financial constraints	0,37	0,48	0,00	1,00
Newly established firms during 2005 - 2007	0,03	0,18	0,00	1,00
Poland				
Innovation Decision	0,22	0,41	0,00	1,00
Small50	0,73	0,44	0,00	1,00
Small100	0,82	0,38	0,00	1,00

Table B – Continued

Variable	Mean	Std. Dev	Min	Max
Firm size	65,72	127,60	1,00	1250,00
R&D intensity	0,04	0,05	3333,00	0,41
Product innovation	0,49	0,50	0,00	1,00
Process innovation	0,62	0,48	0,00	1,00
Share of skilled employees	0,61	0,30	0,00	1,00
More than 5 competitors	0,09	0,28	0,00	1,00
International market	0,04	0,18	0,00	1,00
Informal competition	0,08	0,27	0,00	1,00
Subsidy	0,14	0,34	0,00	1,00
Foreign owned	0,06	0,24	0,00	1,00
Financial constraints	0,33	0,47	0,00	1,00
Newly established firms during 2005 - 2007	0,00	0,05	0,00	1,00
Romania				
Innovation Decision	0,16	0,36	0,00	1,00
Small50	0,64	0,48	0,00	1,00
Small100	0,74	0,44	0,00	1,00
Firm size	121,09	335,98	2,00	5408,00
R&D intensity	0,05	0,05	429,00	0,33
Product innovation	0,41	0,49	0,00	1,00
Process innovation	0,62	0,49	0,00	1,00
Share of skilled employees	0,60	0,28	0,00	1,00
More than 5 competitors	0,10	0,30	0,00	1,00
International market	0,05	0,21	0,00	1,00
Informal competition	0,04	0,19	0,00	1,00
Subsidy	0,09	0,29	0,00	1,00
Foreign owned	0,12	0,33	0,00	1,00
Financial constraints	0,24	0,43	0,00	1,00
Newly established firms during 2005 - 2007	0,01	0,08	0,00	1,00
Serbia				
Innovation Decision	0,39	0,49	0,00	1,00
Small50	0,48	0,50	0,00	1,00
Small100	0,63	0,48	0,00	1,00
Firm size	187,22	416,02	1,00	4000,00
R&D intensity	0,04	0,06	0,00	0,30
Product innovation	0,61	0,49	0	1,00
Process innovation	0,74	0,44	0	1,00
Share of skilled employees	0,46	0,25	0	1,00
More than 5 competitors	0,26	0,44	0	1,00
International market	0,05	0,22	0	1,00
Informal competition	0,26	0,44	0	1,00
Subsidy	0,17	0,37	0	1,00
Foreign owned	0,10	0,30	0	1,00

Table B – Continued

Variable	Mean	Std. Dev	Min	Max
Financial constraints	0,35	0,48	0	1,00
Newly established firms during 2005 - 2007	0,03	0,16	0	1,00
Kazakhnstan				
Innovation Decision	0,15	0,35	0,00	1,00
Small50	0,68	0,47	0,00	1,00
Small100	0,77	0,42	0,00	1,00
Firm size	93,55	173,16	2,00	1586,00
R&D intensity	0,06	0,08	0,00	0,35
Product innovation	0,39	0,49	0,00	1,00
Process innovation	0,55	0,50	0,00	1,00
Share of skilled employees	0,51	0,27	0,00	1,00
More than 5 competitors	0,12	0,33	0,00	1,00
International market	0,01	0,09	0,00	1,00
Informal competition	0,07	0,26	0,00	1,00
Subsidy	0,04	0,20	0,00	1,00
Foreign owned	0,05	0,23	0,00	1,00
Financial constraints	0,21	0,41	0,00	1,00
Newly established firms during 2005 - 2007	0,03	0,18	0,00	1,00
Moldova				
Innovation Decision	0,26	0,44	0,00	1,00
Small50	0,57	0,50	0,00	1,00
Small100	0,72	0,45	0,00	1,00
Firm size	137,46	285,67	2,00	2200,00
R&D intensity	0,06	0,10	0,00	0,50
Product innovation	0,57	0,50	0,00	1,00
Process innovation	0,69	0,46	0,00	1,00
Share of skilled employees	0,54	0,26	0,00	1,00
More than 5 competitors	0,14	0,35	0,00	1,00
International market	0,10	0,30	0,00	1,00
Informal competition	0,14	0,34	0,00	1,00
Subsidy	0,07	0,26	0,00	1,00
Foreign owned	0,14	0,35	0,00	1,00
Financial constraints	0,30	0,46	0,00	1,00
Newly established firms during 2005 - 2007	0,03	0,18	0,00	1,00
Bosnia				
Innovation Decision	0,31	0,46	0,00	1,00
Small50	0,57	0,50	0,00	1,00
Small100	0,70	0,46	0,00	1,00
Firm size	114,54	199,58	2,00	1400,00
R&D intensity	0,04	0,06	0,00	0,44
Product innovation	0,63	0,48	0,00	1,00
Process innovation	0,81	0,39	0,00	1,00

Table B – Continued

Variable	Mean	Std. Dev	Min	Max
Share of skilled employees	0,48	0,30	0,00	1,00
More than 5 competitors	0,17	0,37	0,00	1,00
International market	0,18	0,39	0,00	1,00
Informal competition	0,24	0,43	0,00	1,00
Subsidy	0,20	0,40	0,00	1,00
Foreign owned	0,06	0,24	0,00	1,00
Financial constraints	0,24	0,43	0,00	1,00
Newly established firms during 2005 - 2007	0,03	0,17	0,00	1,00
Azerbaijan				
Innovation Decision	0,09	0,28	0,00	1,00
Small50	0,53	0,50	0,00	1,00
Small100	0,70	0,46	0,00	1,00
Firm size	112,58	187,82	3,00	1387,00
R&D intensity	0,05	0,06	0,00	0,20
Product innovation	0,38	0,49	0,00	1,00
Process innovation	0,61	0,49	0,00	1,00
Share of skilled employees	0,58	0,22	0,00	1,00
More than 5 competitors	0,23	0,42	0,00	1,00
International market	0,05	0,23	0,00	1,00
Informal competition	0,34	0,48	0,00	1,00
Subsidy	0,05	0,23	0,00	1,00
Foreign owned	0,14	0,34	0,00	1,00
Financial constraints	0,38	0,49	0,00	1,00
Newly established firms during 2005 - 2007	0,05	0,21	0,00	1,00
Macedonia				
Innovation Decision	0,24	0,43	0,00	1,00
Small50	0,54	0,50	0,00	1,00
Small100	0,72	0,45	0,00	1,00
Firm size	110,65	223,19	2,00	2092,00
R&D intensity	0,04	0,05	0,00	0,27
Product innovation	0,54	0,50	0,00	1,00
Process innovation	0,71	0,46	0,00	1,00
Share of skilled employees	0,53	0,34	0,00	1,00
More than 5 competitors	0,20	0,40	0,00	1,00
International market	0,25	0,43	0,00	1,00
Informal competition	0,44	0,50	0,00	1,00
Subsidy	0,08	0,28	0,00	1,00
Foreign owned	0,09	0,28	0,00	1,00
Financial constraints	0,22	0,42	0,00	1,00
Newly established firms during 2005 - 2007	0,08	0,27	0,00	1,00

Table B – Continued

Variable	Mean	Std. Dev	Min	Max
Armenia				
Innovation Decision	0,17	0,38	0,00	1,00
Small50	0,74	0,44	0,00	1,00
Small100	0,85	0,36	0,00	1,00
Firm size	59,21	111,10	2,00	1000,00
R&D intensity	0,05	0,08	0,00	0,60
Product innovation	0,53	0,50	0,00	1,00
Process innovation	0,73	0,44	0,00	1,00
Share of skilled employees	0,46	0,28	0,00	0,98
More than 5 competitors	0,08	0,27	0,00	1,00
International market	0,04	0,19	0,00	1,00
Informal competition	0,07	0,25	0,00	1,00
Subsidy	0,02	0,15	0,00	1,00
Foreign owned	0,06	0,24	0,00	1,00
Financial constraints	0,19	0,40	0,00	1,00
Newly established firms during 2005 - 2007	0,03	0,17	0,00	1,00
Kyrgyz				
Innovation Decision	0,20	0,40	0,00	1,00
Small50	0,54	0,50	0,00	1,00
Small100	0,71	0,45	0,00	1,00
Firm size	146,40	311,92	3,00	2331,00
R&D intensity	0,09	0,11	0,00	0,46
Product innovation	0,51	0,50	0,00	1,00
Process innovation	0,69	0,46	0,00	1,00
Share of skilled employees	0,45	0,26	0,00	1,00
More than 5 competitors	0,15	0,36	0,00	1,00
International market	0,07	0,25	0,00	1,00
Informal competition	0,25	0,43	0,00	1,00
Subsidy	0,04	0,19	0,00	1,00
Foreign owned	0,14	0,35	0,00	1,00
Financial constraints	0,22	0,41	0,00	1,00
Newly established firms during 2005 - 2007	0,02	0,13	0,00	1,00
Estonia				
Innovation Decision	0,31	0,47	0,00	1,00
Small50	0,62	0,49	0,00	1,00
Small100	0,73	0,45	0,00	1,00
Firm size	147,06	487,12	2,00	4800,00
R&D intensity	0,02	0,05	0,00	0,33
Product innovation	0,55	0,50	0,00	1,00
Process innovation	0,72	0,45	0,00	1,00
Share of skilled employees	0,48	0,30	0,00	1,00
More than 5 competitors	0,18	0,38	0,00	1,00

Table B – Continued

Variable	Mean	Std. Dev	Min	Max
International market	0,18	0,39	0,00	1,00
Informal competition	0,09	0,28	0,00	1,00
Subsidy	0,24	0,43	0,00	1,00
Foreign owned	0,18	0,39	0,00	1,00
Financial constraints	0,08	0,27	0,00	1,00
Newly established firms during 2005 - 2007	0,02	0,14	0,00	1,00
Czech Republic				
Innovation Decision	0,30	0,46	0,00	1,00
Small50	0,58	0,50	0,00	1,00
Small100	0,71	0,46	0,00	1,00
Firm size	162,95	420,07	2,00	3200,00
R&D intensity	0,03	0,03	0,00	0,17
Product innovation	0,55	0,50	0,00	1,00
Process innovation	0,64	0,48	0,00	1,00
Share of skilled employees	0,40	0,33	0,00	1,00
More than 5 competitors	0,11	0,32	0,00	1,00
International market	0,11	0,31	0,00	1,00
Informal competition	0,13	0,34	0,00	1,00
Subsidy	0,19	0,39	0,00	1,00
Foreign owned	0,13	0,34	0,00	1,00
Financial constraints	0,20	0,40	0,00	1,00
Newly established firms during 2005 - 2007	0,03	0,16	0,00	1,00
Hungury				
Innovation Decision	0,19	0,39	0,00	1,00
Small50	0,59	0,49	0,00	1,00
Small100	0,71	0,45	0,00	1,00
Firm size	142,82	313,83	2,00	3400,00
R&D intensity	0,02	0,03	0,00	0,20
Product innovation	0,38	0,48	0,00	1,00
Process innovation	0,56	0,50	0,00	1,00
Share of skilled employees	0,51	0,31	0,00	1,00
More than 5 competitors	0,06	0,24	0,00	1,00
International market	0,05	0,22	0,00	1,00
Informal competition	0,11	0,31	0,00	1,00
Subsidy	0,25	0,43	0,00	1,00
Foreign owned	0,20	0,40	0,00	1,00
Financial constraints	0,20	0,40	0,00	1,00
Newly established firms during 2005 - 2007	0,02	0,13	0,00	1,00
Latvia				
Innovation Decision	0,23	0,42	0,00	1,00
Small50	0,48	0,50	0,00	1,00
Small100	0,63	0,48	0,00	1,00

Table B – Continued

Variable	Mean	Std. Dev	Min	Max
Firm size	130,15	194,86	2,00	1450,00
R&D intensity	0,02	0,02	0,00	0,10
Product innovation	0,54	0,50	0,00	1,00
Process innovation	0,82	0,39	0,00	1,00
Share of skilled employees	0,49	0,30	0,00	1,00
More than 5 competitors	0,14	0,35	0,00	1,00
International market	0,17	0,38	0,00	1,00
Informal competition	0,18	0,38	0,00	1,00
Subsidy	0,20	0,40	0,00	1,00
Foreign owned	0,23	0,42	0,00	1,00
Financial constraints	0,11	0,32	0,00	1,00
Newly established firms during 2005 - 2007	0,05	0,21	0,00	1,00
Lithuania				
Innovation Decision	0,34	0,47	0,00	1,00
Small50	0,60	0,49	0,00	1,00
Small100	0,70	0,46	0,00	1,00
Firm size	108,90	175,47	2,00	1231,00
R&D intensity	0,04	0,06	0,00	0,30
Product innovation	0,69	0,46	0,00	1,00
Process innovation	0,79	0,41	0,00	1,00
Share of skilled employees	0,45	0,31	0,00	0,94
More than 5 competitors	0,17	0,38	0,00	1,00
International market	0,17	0,38	0,00	1,00
Informal competition	0,13	0,33	0,00	1,00
Subsidy	0,18	0,39	0,00	1,00
Foreign owned	0,16	0,37	0,00	1,00
Financial constraints	0,18	0,38	0,00	1,00
Newly established firms during 2005 - 2007	0,05	0,22	0,00	1,00
Slovakia				
Innovation Decision	0,25	0,43	0,00	1,00
Small50	0,51	0,50	0,00	1,00
Small100	0,66	0,48	0,00	1,00
Firm size	247,44	841,95	2,00	9500,00
R&D intensity	0,04	0,06	0,00	0,20
Product innovation	0,56	0,50	0,00	1,00
Process innovation	0,79	0,41	0,00	1,00
Share of skilled employees	0,50	0,31	0,00	1,00
More than 5 competitors	0,15	0,36	0,00	1,00
International market	0,13	0,34	0,00	1,00
Informal competition	0,17	0,37	0,00	1,00
Subsidy	0,14	0,35	0,00	1,00
Foreign owned	0,10	0,30	0,00	1,00

Table B – Continued

Variable	Mean	Std. Dev	Min	Max
Financial constraints	0,19	0,39	0,00	1,00
Newly established firms during 2005 - 2007	0,04	0,19	0,00	1,00
Slovenia				
Innovation Decision	0,54	0,50	0,00	1,00
Small50	0,49	0,50	0,00	1,00
Small100	0,63	0,48	0,00	1,00
Firm size	179,70	316,83	2,00	2650,00
R&D intensity	0,03	0,03	0,00	0,18
Product innovation	0,59	0,49	0,00	1,00
Process innovation	0,79	0,41	0,00	1,00
Share of skilled employees	0,46	0,26	0,00	1,00
More than 5 competitors	0,13	0,34	0,00	1,00
International market	0,19	0,39	0,00	1,00
Informal competition	0,10	0,30	0,00	1,00
Subsidy	0,34	0,47	0,00	1,00
Foreign owned	0,18	0,38	0,00	1,00
Financial constraints	0,11	0,31	0,00	1,00
Newly established firms during 2005 - 2007	0,02	0,13	0,00	1,00
Bulgaria				
Innovation Decision	0,06	0,24	0,00	1,00
Small50	0,61	0,49	0,00	1,00
Small100	0,75	0,43	0,00	1,00
Firm size	95,06	184,41	2,00	3100,00
R&D intensity	0,03	0,04	0,00	0,18
Product innovation	0,12	0,32	0,00	1,00
Process innovation	0,14	0,35	0,00	1,00
Share of skilled employees	0,56	0,32	0,00	1,00
More than 5 competitors	0,06	0,24	0,00	1,00
International market	0,15	0,35	0,00	1,00
Informal competition	0,38	0,49	0,00	1,00
Subsidy	0,01	0,10	0,00	1,00
Foreign owned	0,09	0,28	0,00	1,00
Financial constraints	0,22	0,41	0,00	1,00
Newly established firms during 2005 - 2007	0,03	0,17	0,00	1,00
Croatia				
Innovation Decision	0,11	0,31	0,00	1,00
Small50	0,62	0,49	0,00	1,00
Small100	0,73	0,44	0,00	1,00
Firm size	119,69	278,27	1,00	4000,00
R&D intensity	0,04	0,06	0,00	0,33
Product innovation	0,12	0,33	0,00	1,00
Process innovation	0,20	0,40	0,00	1,00

Table B – Continued

Variable	Mean	Std. Dev	Min	Max
Share of skilled employees	0,46	0,30	0,00	1,00
More than 5 competitors	0,33	0,47	0,00	1,00
International market	0,15	0,36	0,00	1,00
Informal competition	0,24	0,43	0,00	1,00
Subsidy	0,05	0,22	0,00	1,00
Foreign owned	0,09	0,29	0,00	1,00
Financial constraints	0,21	0,41	0,00	1,00
Newly established firms during 2005 - 2007	0,01	0,08	0,00	1,00

APPENDIX C

Table C1. Selection Equation and Innovation Input Equation with small firm defined as less one hundred employees, BEEPS

Variables	Selection Equation	Innovation Input Equation
Small100	**-0.635***	0.126
	(0.045)	(0.675)
Small100modern	0.188	-0.0647
	(0.620)	(0.584)
Informal competition	-0.0547	0.0214
	(0.788)	(0.526)
More than 5 competitors	**0.690****	-0.0335
	(0.003)	(0.911)
Skilled labor share	0.102	0.00772
	(0.770)	(0.909)
Subsidy	0.283	-0.0247
	(0.572)	(0.844)
Newly established	-0.660	-0.0319
	(0.180)	(0.923)
International market	0.497	-0.00649
	(0.094)	(0.976)
Financial constraints	0.163	-0.00416
	(0.370)	(0.958)
Constant	**-1.697*****	0.0942
	(0.000)	(0.938)
mills	-0.0224	-
lambda	(0.970)	-
Observations	380	55

p-values in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
four industry dummies were included in each equation

Table C2. Selection equation for transition countries with small firm defined as less than fifty employees.
Dependent variable: Innovation Decision – probability of investing in R&D

	Albania	**Belarus**	**Georgia**	**Tajikistan**	**Turkey**
Small50	-0.591	-0.188	-0.792*	-1.006***	-0.367**
	(0.085)	(0.434)	(0.018)	0	(0.002)
Small50modern	-0.305	0.626	0.461	0.0601	-0.242
	(0.513)	(0.095)	(0.208)	(0.894)	(0.117)
Informal competition	-5.662	-0.246	-1.502**	-0.271	0.408***
	.	(0.544)	(0.003)	(0.496)	0
More than 5 competitors	-0.489	0.138	-0.114	-0.662	0.437***
	(0.379)	(0.644)	(0.793)	(0.122)	0
Skilled labor share	-0.385	0.416	0.977	-0.0747	-0.428***
	(0.501)	(0.323)	(0.065)	(0.87)	(0.001)
Subsidy	0.693	0.113	-0.144	0.183	0.638***
	(0.253)	(0.773)	(0.812)	(0.76)	0
Newly established	-5.28	0	0.377	-5.825	0.381
	.	0	(0.53)	.	(0.251)
International market	-5.524	-0.368	0.987	-5.925	0.871***
	.	(0.599)	(0.058)	.	0
Financial constraints	0.15	-0.41	-0.262	0.13	-0.17
	(0.689)	(0.154)	(0.468)	(0.631)	(0.174)
Constant	-0.43	-0.827*	-0.69	-0.324	-1.294***
	(0.332)	(0.011)	(0.147)	(0.283)	0
mills lambda	0.152	0.375	-0.357	-2.576	-0.905
	(0.95)	(0.939)	(0.869)	(0.934)	(0.589)
Observations	183	169	155	219	1423
	Uzbekistan	**Russia**	**Poland**	**Romania**	**Serbia**
Small50	-0,375	-0.813***	-1.101***	-0.584***	-0.723***
	(0.101)	0	0	0	(0.001)
Small50modern	-0,459	0.501**	0.363*	0,0656	0,317
	(0.16)	(0.002)	(0.021)	(0.727)	(0.276)
Informal competition	-0,594	-0,0467	-0,0966	0,307	-0,0818
	(0.124)	(0.699)	(0.726)	(0.388)	(0.734)
More than 5 competitors	-0,592	0,128	-0,346	-0,0793	0,283
	(0.155)	(0.245)	(0.161)	(0.736)	(0.23)
Skilled labor share	-0,577	0.872***	0,197	0,317	0,228
	(0.17)	0	(0.379)	(0.224)	(0.531)
Subsidy	0,161	0,269	0,292	-0,0823	0,128
	(0.814)	(0.15)	(0.067)	(0.716)	(0.607)
Newly established	0,932	-0,194	1,468	-5,239	-0,68
	(0.146)	(0.497)	(0.117)	.	(0.288)
International market	-6,139	0.867*	-0,439	-0,0583	-0,291
	.	(0.025)	(0.178)	(0.854)	(0.509)
Financial constraints	-0,0245	-0,168	0,0228	0,0152	0,00458
	(0.927)	(0.117)	(0.854)	(0.924)	(0.981)
Constant	-0,259	-0.613***	-0,0444	-0.704**	0,0211
	(0.412)	0	(0.818)	(0.001)	(0.931)
mills lambda	0,999	0,27	0,112	0,536	0,397
	(0.908)	(0.904)	(0.618)	(0.902)	(0.893)
Observations	256	830	679	559	223
	Kazakhstan	**Moldova**	**Bosnia**	**Azerbaijan**	**Macedonia**
Small50	-0.483**	-1.198***	0.0712	-0.2	-0.427
	(0.005)	0	(0.755)	(0.696)	(0.109)
Small50modern	-0.292	0.436	-0.352	-0.124	0.425
	(0.149)	(0.14)	(0.225)	(0.844)	(0.237)

Table C2 – Continued

	Kazakhstan	**Moldova**	**Bosnia**	**Azerbaijan**	**Macedonia**
Informal competition	0.122	0.0675	0.345	0.0357	0.283
	(0.681)	(0.811)	(0.171)	(0.948)	(0.26)
More than 5 competitors	-0.670*	0.491	0.164	-6.439	0.864**
	(0.02)	(0.072)	(0.554)	.	(0.005)
Skilled labor share	0.0116	0.0551	0.0816	-1.916*	1.168**
	(0.967)	(0.874)	(0.815)	(0.049)	(0.007)
Subsidy	0.355	-0.332	-0.0996	1.506*	-0.0591
	(0.295)	(0.326)	(0.685)	(0.011)	(0.878)
Newly established	-0.429	-0.872	0.943	-4.882	0.148
	(0.43)	(0.141)	(0.11)	.	(0.715)
International market	0.0481	0.0443	0.469	0.928	-0.075
	(0.947)	(0.885)	(0.079)	(0.213)	(0.822)
Financial constraints	0.0289	-0.0139	0.325	-1.603*	0.47
	(0.873)	(0.947)	(0.156)	(0.028)	(0.073)
Constant	-0.591**	-0.253	-0.807**	0.0899	-1.503***
	(0.006)	(0.396)	(0.005)	(0.872)	0
mills lambda	1.085	0.00471	-0.00039	3.773	0.0725
	(0.912)	(0.996)	(0.999)	(0.965)	(0.675)
Observations	502	277	215	148	193
	Armenia	**Kyrgyz**	**Estonia**	**Czech Republic**	**Hungary**
Small50	-0.741***	-0.704*	-0.991***	-0.911***	-0.872***
	(0.001)	(0.036)	0	0	0
Small50modern	0.499*	0.285	0.879*	0.620*	0.208
	(0.027)	(0.465)	(0.015)	(0.021)	(0.368)
Informal competition	-0.29	-0.0759	-0.0124	0.148	-0.281
	(0.456)	(0.815)	(0.976)	(0.622)	(0.311)
More than 5 competitors	-0.324	-0.731	-0.403	-0.197	-0.31
	(0.393)	(0.105)	(0.206)	(0.544)	(0.449)
Skilled labor share	0.617	0.705	-0.335	0.467	-0.332
	(0.057)	(0.13)	(0.333)	(0.108)	(0.183)
Subsidy	0.579	0.399	0.00136	0.476*	0.289
	(0.265)	(0.495)	(0.996)	(0.04)	(0.074)
Newly established	0.920*	0.91	0.311	-6.03	-6.285
	(0.044)	(0.282)	(0.663)	.	.
International market	0.426	-0.318	-0.53	-0.0478	0.423
	(0.269)	(0.516)	(0.074)	(0.876)	(0.185)
Financial constraints	0.359	0.109	-0.45	0.128	0.227
	(0.072)	(0.701)	(0.276)	(0.58)	(0.213)
Constant	-0.897***	-1.111**	0.397	-0.453*	-0.425*
	0	(0.003)	(0.173)	(0.035)	(0.022)
mills lambda	0.519	-0.831	0.189	-0.157	0.213
	(0.787)	(0.864)	(0.797)	(0.784)	(0.834)
Observations	361	181	194	240	464
	Latvia	**Lithuania**	**Slovakia**	**Slovenia**	**Bulgaria**
Small50	-0.745**	-0.590*	-0.998**	-0.715***	-0.281
	(0.005)	(0.012)	(0.003)	(0.001)	(0.163)
Small50modern	-0.505	0.0914	0.535	0.0305	-0.438
	(0.395)	(0.766)	(0.162)	(0.922)	(0.066)
Informal competition	0.0109	-0.629	0.0877	-0.252	-1.281***
	(0.975)	(0.082)	(0.823)	(0.438)	0
More than 5 competitors	-0.749	-0.111	-0.381	-0.202	0.363
	(0.073)	(0.714)	(0.395)	(0.496)	(0.169)
Skilled labor share	-0.0924	-0.0128	-0.182	0.0681	0.217

Table C2 – Continued

	Latvia	**Lithuania**	**Slovakia**	**Slovenia**	**Bulgaria**
	(0.814)	(0.97)	(0.678)	(0.847)	(0.419)
Subsidy	0.0259	0.348	0.226	0.35	0.303
	(0.928)	(0.178)	(0.565)	(0.096)	(0.56)
Newly established	1.159*	-6.301	0.0976	-6.408	-5.098
	(0.038)	.	(0.895)	.	.
International market	-0.748*	-0.187	-0.385	-0.28	-1.296**
	(0.046)	(0.54)	(0.288)	(0.273)	(0.001)
Financial constraints	-0.536	0.311	0.127	-0.348	0.440*
	(0.208)	(0.267)	(0.702)	(0.25)	(0.018)
Constant	-0.252	0.147	-0.026	0.648*	-1.141***
	(0.394)	(0.62)	(0.938)	(0.01)	0
mills lambda	-0.319	-0.595	-0.262	0.0664	-0.163
	(0.905)	(0.824)	(0.751)	(0.666)	(0.913)
Observations	177	196	156	218	823
	Croatia				
Small50	-0.776***				
	0				
Smal50modern	0.42				
	(0.081)				
Informal competition	-0.155				
	(0.476)				
More than 5 competitors	-0.450*				
	(0.031)				
Skilled labor share	0.689*				
	(0.019)				
Subsidy	1.098***				
	0				
Newly established	-4.623				
	.				
International market	-1.262***				
	(0.001)				
Financial constraints	0.194				
	(0.324)				
Constant	-1.089***				
	0				
mills lambda	0.144				
	(0.731)				
Observations	520				

p-values in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
four industry dummies were included in each equation

Table C3. Selection equation for transition countries with small firm defined as less one hundred employees.
Dependent variable: Innovation Decision – probability of investing in R&D

	Albania	**Belarus**	**Georgia**	**Tajikistan**	**Turkey**
Small100	-0.562**	-0.0727	-0.561**	-0.381**	-0.213***
	(0.003)	(0.554)	(0.002)	(0.002)	(0.000)
Small100modern	-0.0134	0.229	0.105	0.0377	-0.0990
	(0.946)	(0.178)	(0.537)	(0.812)	(0.157)
Informal competition	-5.989	-0.263	-1.427**	-0.241	0.409***
	.	(0.512)	(0.008)	(0.529)	(0.000)
More than 5 competitors	-0.300	0.160	-0.142	-0.702	0.431***
	(0.569)	(0.590)	(0.746)	(0.084)	(0.000)
Skilled labor share	-0.363	0.382	1.063*	-0.0989	-0.438***
	(0.541)	(0.356)	(0.047)	(0.827)	(0.000)
Subsidy	0.890	0.0995	-0.474	0.179	0.646***
	(0.144)	(0.800)	(0.460)	(0.768)	(0.000)
Newly established	-4.954	-0.308	0.407	-5.262	0.420
	.	(0.653)	(0.506)	.	(0.206)
International market	-5.944	-0.448	1.030	-5.996	0.849***
	.	(0.116)	(0.052)	.	(0.000)
Financial constraints	0.351	-0.0727	-0.253	0.185	-0.158
	(0.366)	(0.554)	(0.507)	(0.486)	(0.204)
Constant	-0.0697	-0.798*	-0.448	-0.181	-1.231***
	(0.886)	(0.014)	(0.366)	(0.562)	(0.000)
mills lambda	-1.165	2.104	0.0649	-5.330	-0.890
	(0.955)	(0.945)	(0.881)	(0.950)	(0.592)
Observations	183	169	155	219	1423
	Uzbekistan	**Russia**	**Poland**	**Romania**	**Serbia**
Small100	-0.323**	-0.316***	-0.440***	-0.275***	-0.429***
	(0.006)	(0.000)	(0.000)	(0.001)	(0.000)
Small100modern	-0.289	0.201**	0.183**	0.0758	0.179
	(0.066)	(0.003)	(0.009)	(0.375)	(0.164)
Informal competition	-0.529	-0.0451	-0.0179	0.237	-0.109
	(0.177)	(0.707)	(0.947)	(0.505)	(0.656)
More than 5 competitors	-0.592	0.172	-0.334	-0.0630	0.340
	(0.164)	(0.116)	(0.171)	(0.790)	(0.151)
Skilled labor share	-0.667	0.833***	0.140	0.286	0.270
	(0.113)	(0.000)	(0.519)	(0.276)	(0.462)
Subsidy	-0.0136	0.278	0.464**	-0.0685	0.149
	(0.984)	(0.136)	(0.003)	(0.762)	(0.550)
Newly established	0.985	-0.218	1.243	-4.775	-0.678
	(0.124)	(0.441)	(0.174)	.	(0.297)
International market	-5.993	0.911*	-0.222	0.0210	-0.295
	.	(0.020)	(0.481)	(0.947)	(0.510)
Financial constraints	-0.0175	-0.158	0.0124	0.0201	-0.0224
	(0.949)	(0.135)	(0.919)	(0.898)	(0.906)
Constant	0.0162	-0.592***	-0.101	-0.673**	0.165
	(0.961)	(0.000)	(0.618)	(0.004)	(0.519)
mills lambda	0.504	0.183	0.195	0.482	0.285
	(0.853)	(0.941)	(0.635)	(0.915)	(0.824)
Observations	256	830	679	559	223
	Kazakhstan	**Moldova**	**Bosnia**	**Azerbaijan**	**Macedonia**
Small100	-0.285**	-0.659***	-0.128	0.0990	-0.180
	(0.002)	(0.000)	(0.279)	(0.710)	(0.191)
Small100modern	-0.0978	0.175	-0.163	0.00882	0.329*
	(0.286)	(0.182)	(0.226)	(0.972)	(0.034)

Table C3 – Continued

	Kazakhstan	**Moldova**	**Bosnia**	**Azerbaijan**	**Macedonia**
Informal competition	0.138	0.0271	0.386	0.0115	0.320
	(0.644)	(0.924)	(0.127)	(0.983)	(0.206)
More than 5 competitors	-0.731*	0.474	0.232	-6.570	0.839**
	(0.012)	(0.084)	(0.408)	.	(0.007)
Skilled labor share	0.0535	-0.00394	0.0877	-1.998*	1.212**
	(0.847)	(0.991)	(0.802)	(0.044)	(0.005)
Subsidy	0.438	-0.323	-0.134	1.514*	-0.0714
	(0.196)	(0.346)	(0.582)	(0.012)	(0.853)
Newly established	-0.454	-0.780	1.028	-5.108	0.174
	(0.410)	(0.195)	(0.082)	.	(0.669)
International market	0.112	0.0778	0.481	1.185	-0.000291
	(0.879)	(0.802)	(0.072)	(0.115)	(0.999)
Financial constraints	0.0278	-0.0959	0.291	-1.681*	0.458
	(0.877)	(0.648)	(0.207)	(0.031)	(0.084)
Constant	-0.533*	0.243	-0.592	-0.0391	-1.630***
	(0.015)	(0.457)	(0.050)	(0.946)	(0.000)
mills lambda	0.728	-0.567	-0.313	1.965	0.0943
	(0.892)	(0.851)	(0.800)	(0.956)	(0.578)
Observations	502	277	215	148	193
	Armenia	**Kyrgyz**	**Estonia**	**Czech Republic**	**Hungary**
Small100	-0.272*	-0.293	-0.566***	-0.243*	-0.394***
	(0.024)	(0.052)	(0.000)	(0.029)	(0.000)
Small100modern	0.236*	-0.0388	0.449**	0.159	0.0816
	(0.023)	(0.811)	(0.006)	(0.168)	(0.401)
Informal competition	-0.197	0.0636	0.0386	0.100	-0.244
	(0.609)	(0.845)	(0.926)	(0.735)	(0.373)
More than 5 competitors	-0.329	-0.808	-0.289	-0.233	-0.246
	(0.386)	(0.073)	(0.358)	(0.468)	(0.550)
Skilled labor share	0.624	0.826	-0.279	0.505	-0.295
	(0.052)	(0.074)	(0.422)	(0.077)	(0.234)
Subsidy	0.490	0.430	-0.0171	0.521*	0.315
	(0.344)	(0.448)	(0.947)	(0.021)	(0.050)
Newly established	0.811	0.734	0.407	-6.027	-6.398
	(0.073)	(0.367)	(0.575)	.	.
International market	0.521	-0.221	-0.518	0.124	0.456
	(0.178)	(0.659)	(0.079)	(0.682)	(0.151)
Financial constraints	0.332	0.0590	-0.529	0.0945	0.171
	(0.094)	(0.834)	(0.208)	(0.678)	(0.338)
Constant	-0.943***	-0.999**	0.543	-0.573*	-0.375
	(0.001)	(0.010)	(0.079)	(0.013)	(0.053)
mills lambda	0.436	-2.501	0.139	-0.145	0.0527
	(0.799)	(0.913)	(0.754)	(0.835)	(0.820)
Observations	361	181	194	240	464
	Latvia	**Lithuania**	**Slovakia**	**Slovenia**	**Bulgaria**
Small100	-0.376**	-0.383**	-0.491**	-0.338**	-0.221*
	(0.004)	(0.001)	(0.001)	(0.001)	(0.031)
Small100modern	-0.0770	0.0817	0.349*	0.0478	-0.161
	(0.732)	(0.570)	(0.035)	(0.724)	(0.132)
Informal competition	0.00510	-0.599	0.304	-0.290	-1.253***
	(0.988)	(0.103)	(0.441)	(0.375)	(0.000)
More than 5 competitors	-0.689	-0.0996	-0.578	-0.153	0.432
	(0.097)	(0.746)	(0.190)	(0.596)	(0.104)

Table C3 – Continued

	Latvia	**Lithuania**	**Slovakia**	**Slovenia**	**Bulgaria**
Skilled labor share	-0.0638	0.00149	-0.253	0.111	0.135
	(0.871)	(0.997)	(0.568)	(0.753)	(0.616)
Subsidy	0.0783	0.398	0.391	0.415*	0.370
	(0.782)	(0.125)	(0.312)	(0.046)	(0.479)
Newly established	0.972	-6.556	-0.102	-6.504	-5.310
	(0.069)	.	(0.891)	.	.
International market	-0.677	-0.207	-0.442	-0.211	-1.315**
	(0.069)	(0.502)	(0.241)	(0.409)	(0.001)
Financial constraints	-0.478	0.394	0.0208	-0.418	0.451*
	(0.265)	(0.168)	(0.949)	(0.160)	(0.015)
Constant	-0.101	0.298	0.0794	0.656*	-0.957***
	(0.754)	(0.333)	(0.825)	(0.011)	(0.000)
mills lambda	-0.529	-0.263	-0.351	0.102	0.0752
	(0.899)	(0.759)	(0.745)	(0.656)	(0.904)
Observations	177	196	156	218	823
	Croatia				
Small100	-0.403***				
	(0.000)				
Small100modern	0.201				
	(0.065)				
Informal competition	-0.168				
	(0.439)				
More than 5 competitors	-0.490*				
	(0.019)				
Skilled labor share	0.707*				
	(0.017)				
Subsidy	1.102***				
	(0.000)				
Newly established	-4.666				
	.				
International market	-1.310***				
	(0.001)				
Financial constraints	0.196				
	-0.403***				
Constant	-0.994***				
	(0.000)				
mills lambda	-0.00317				
	(0.988)				
Observations	520				

p-values in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
four industry dummies were included in each equation