

Monetary and Fiscal Policy Regimes and Firm Innovation in Transition Economies and Residual Factors Explaining the Gap in Firm Innovation in Central Asian Economies

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Abstract

In this paper, we investigate the relationships between monetary and fiscal policy regimes and firm innovation in 25 transition economies. Using three waves of the Business Environment and Enterprise Performance Survey, we find that firm innovation increases with the inflation adjusted interest rate. Results also show that more stringent tax regimes lead to a decline in firm innovation. We then explore the factors attributable to the lag in innovative activities in the firms located in the Central Asian republics. We find that the current fiscal and monetary regimes actually reduce the gap between firm innovation in Central Asian and European transition economies. The residual gap can mainly be explained by differences in a variety of firm and country level characteristics.

Keywords: *Firm innovation, Transition economics, Business Environment and Enterprise Performance Survey, Central Asia*

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1. Introduction

The government plays a substantial role in the promotion of technological progress in the workplaces because, regardless of the form of technological progress -- development or adoption of new technologies -- perpetual involvement of firms in various innovative activities inevitably leads the economy to sustainable growth (Segerstrom, 1991). Therefore, irrespective of the current stage of economic development, most governments, especially those that are transitioning from the centrally planned economic system to the market-based system are advised to undertake economic policies aimed at increasing a firm's willingness to generate and adopt new technologies.

There are multiple factors that can be directly associated with firm innovation. The monetary and fiscal policy instruments in the form of inflation adjusted interest rate and corporate and personal income tax rates are among them. As shown in Jorgensen (1963), these three policy instruments are indispensable factors in a firm's investment and innovation decision making. Previous studies have found the importance of some monetary policy elements in firm innovation (King and Levine, 1993; Alfaro and Kalemli-Ozcan, 2004; Sharma, 2007; Nanda and Nicholas, 2012); however, to our knowledge, no studies have explored these empirical associations for developing and transition economies. Despite the fact that many studies in the past have studied the ways the various tax incentives embedded into the tax systems relate to the

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firm's decision to innovate (Dagenais et al., 2004; Mairesse and Mulkey, 2004; Duguet, 2007; Haegeland and Moen, 2007; Lokshin and Mohnen, 2007), surprisingly, the effects of major fiscal policy instruments such as corporate and personal income taxes on firm innovation remain untapped in the literature, except a study by Fazzari et al. (1988).

To fill the gap in the literature, in this paper we investigate the factors associated with firm innovation with respect to the inflation adjusted interest rate and two fiscal policy instruments such as the average tax rate on corporation profits and average tax rate on income and capital gains. We believe the latter two variables approximate the regimes of corporate and personal income taxation in the economy. To tackle our main empirical inquiry, we focus on a representative sample of private and public firms functioned in 25 transition economies in the period between 2002 and 2009 using the Business Environment and Enterprise Performance Surveys. Our main econometric strategy is centered on cross-country and time variations in monetary and fiscal policy regimes and firm innovation activities in select countries.

The combination of both monetary and fiscal policy regimes can have a significant impact on the economic growth of any country. In developed countries, well-functioning banking and fiscal systems facilitate the steady growth. In the formerly planned economies, where central banks were initially responsible for both central and commercial banking, in the first years of transition to the market-based economy, market-oriented institutions were introduced. Today, after more than two decades of post-communist transition, relatively independent central banks, which are in charge of setting monetary policy, have been developed and the newly established commercial banks have become the main providers of financial services to firms in all transition economies. Despite the fact that the degree of independence of central banks and the involvement of commercial banks in the provision of financial services differ widely across transition economies; aggregately, these economies are homogenous with respect to initial monetary and fiscal environments. The homogeneity of economic environments with respect to initial conditions provides to researchers with the opportunity to pursue empirical investigations of many untapped economic associations using variations in the development of different market structures across countries. This is the main reason why we investigate the association between monetary and fiscal policy regimes and firm innovation using the representative sample of firms representing all transition economies instead of the firms representing developed countries with different heterogeneous economic environments.

As we noted earlier, financial and fiscal environments throughout the transition period have not developed evenly, with wide differences among the different groups of countries. So-called fast-track countries of Central Europe (Poland, Hungary and the Czech Republic) were able to quickly create the full continuum of monetary and fiscal institutions during the first decade of transition. They are followed by the Baltic and South East European transition economies where, although financial sectors are far from perfect, remarkable progress in monetary and fiscal policy reforms has been made in the recent years. Finally, there are Central Asian transition economies with allegedly relatively immature monetary and fiscal authorities and market structures. These countries are accused by many experts of having too many institutional and legislative holes in their banking and fiscal systems, leading to lags in transitioning to market-based economies. Furthermore, immature fiscal and monetary institutions can be major causes of the passive level of adoption of new technologies by firms located in these republics. As evidence, we find that the Central Asian countries lag other transition economies substantially in the level of firm innovation.

As a result of the observed lag in firm innovation in the Central Asian economies compared with the other transition economies, the second objective of this study is to understand the extent to which the observed lag in firm innovation is explained by differences in monetary and fiscal policy regimes. Furthermore, our empirical strategy enables us to identify other firm and country-level characteristics that can be responsible for the lag in firm innovation in the Central Asian economies. Our second empirical inquiry should help in instrumenting optimal policy regimes aimed at closing the gap in firm innovative activities in the Central Asian economies compared to the more market-oriented transition economies.

This paper is structured as follows. In the next section, we provide the conceptual framework that explains the link between monetary and fiscal policy instruments and firm innovation. In Section 3, we derive our main empirical specification of firm innovation based on the model adopted from Jorgensen (1963). In Section 4, we discuss the main data sources used to address our research inquiries and provide information on firm innovation and monetary and fiscal policy regimes in and across transition economies. Furthermore, in this section, we provide descriptive statistics on key variables used in the empirical analyses. In Section 5, we discuss our main results. Finally, we conclude and provide policy recommendations in Section 6.

2. Conceptual Framework

Before outlining the conceptual framework of the relationships between monetary and fiscal policy instruments and firm innovation, we first would like to distinguish two separate processes of firms' decision making. Specifically, because Jorgensen's model targets a firm's investment behavior and we adopt his framework to derive our empirical specification of firm innovation, we need to discuss the main differences and similarities between firms' innovation and investment decisions. The latter discussion should help us better judge whether the latter framework is adoptable for our empirical inquiry. The term "investment" mainly refers to the event when the firm acquires some fixed assets in the form of machinery, vehicles, equipment, land or buildings. At the same time, in the economic literature, three types of innovation are mostly recognized: the introduction of new equipment or new methods of organization or new products and services. Only the first type of innovation activities directly involves the acquisition of fixed assets perfectly connecting the firm's investment decision with the innovation decision.² Therefore, restricting our attention to the introduction of new equipment in the production process in our empirical specification of firm innovation, we equalize two processes: "innovation" and "investment." Under this condition, we can directly apply Jorgensen's (1963) conceptual framework, which would help us gain a better understanding of the way monetary and fiscal policy instruments relate to a firm's behavior to innovate.

As suggested by Jorgensen (1963), the investment decision of the firm can be elucidated by the well-known concept in the literature as the user cost of capital – the rate of return that the new investment project must attain to be considered as profitable. Under the above condition, this framework can be adapted to the situation when the firm decides whether to invest in the new project related to the introduction of new technology in the production process. The logic behind this concept is very simple: the lower the user cost of capital, the higher the likelihood that the firm will pursue the new innovative project. For example, in a very simplistic model that ignores any fiscal policy instruments, the firm will acquire the new innovative good in the form of new

² According to this definition of innovation, the innovative firm replaces its old product line with the line with more advanced technology. Though it increases the total cost of production, it allows the firm to improve productivity of the average worker due to the adoption of new technology.

machinery or equipment if the return from this good (C) minus the level of economic depreciation of it (δ) is greater than the opportunity cost (r) of the internal equity used to purchase this good.

$$C - \delta \geq r \quad (1)$$

In the above equation, the opportunity cost of capital is the real interest rate formed in the capital market. For example, if instead of buying the new investment good, the firm decides to loan its capital to someone else through the capital market (the alternative use of capital), then the firm would receive interest in the amount of r cents for each dollar loaned.

In a simplified version of the model, we assume that the firm doesn't have any restrictions in accessing either its internal or external equity without any discrimination in the interest rate. This implies that we rule out any possibility that the firm may deal with any liquidity restrictions to pursue the new innovative project. This simple model predicts that the changes in the real interest rate have a direct impact on a minimum return that the new innovative project must attain to be profitable; thus, the monetary policy instruments have a direct impact on the firm's innovation decision.

We can extend the model assuming that the firm faces different interest rate regimes for internal and external equities (Chirinko, 2002). Suppose that r_b is the interest rate that a firm should pay for 1 dollar of investment financed through the external debt. Suppose also that w is the proportion of investment financed through borrowing, then the user cost of capital (C) is a combination of the weighted average of the interest payment and opportunity cost of using internal equity to finance the new technology and the economic depreciation of a new asset.

$$C = (1 - w)r + wr_b + \delta \quad (2)$$

In the country with the investment-friendly monetary policy regime, the distance between r and r_b should be somewhere close to zero. This is the case when in the absence of internal equity, the firm has easy access to the capital market and is able to borrow any amount of capital to finance the new technology at the interest rate almost equal to the opportunity cost of internal capital if it was used to finance this project. In contrast, in the country with the investment-unfriendly monetary policy regime, the distance between r and r_b will be substantially large. In such an environment, it isn't straightforward to get a loan from financial institutions and, even if the firm is offered a loan to finance its new project, the interest rate could be too prohibitive, substantially increasing the user cost of capital and negatively affecting the propensity to invest.

The comparative analysis of the firm's innovation decision without a close consideration of fiscal policy parameters can be deemed as incomplete. Suppose that θ is the corporate tax rate and t is the personal income tax rate that any firm faces in the given economy. The profitability of the new project will be reduced by both the corporate and income taxes. For example, a 1 dollar return from new technology will be first reduced by the corporate tax, $(1 - \theta)$, and then, after paying the corporate tax, the earnings of the corporation from the new investment project if it is transferred to the owner of the corporation will be further reduced by the personal income tax, $(1 - t)$. Incorporating both types of taxes and assuming that the distance between r and r_b is given by ε , the rate of return that the new investment project must attain to be considered as profitable is:

$$C = \frac{(1-w)r + wr_b + \delta}{(1-\theta)(1-t)} = \frac{r + w\varepsilon + \delta}{(1-\theta)(1-t)} \quad (3)$$

The main implications from the comparative analysis using equation (3) for our empirical investigation are threefold:

1) Firm innovation is a decreasing function of the real interest rate such that an increase in the real interest rate increases the user cost of capital, decreasing the firm's chance of pursuing any new innovative project,

$$\frac{\partial C}{\partial r} = \frac{1}{(1-\theta)(1-t)} > 0$$

2) Firm innovation is a decreasing function of the corporate tax rate such that an increase in the corporate tax rate increases the user cost of capital, decreasing the firm's chance of pursuing any new innovative project,

$$\frac{\partial C}{\partial \theta} = \frac{r + w\varepsilon + \delta}{(1-\theta)^2(1-t)} > 0$$

3) Firm innovation is a decreasing function of the personal income tax rate such that an increase in the personal income tax rate increases the user cost of capital, decreasing the firm's chance of pursuing any new innovative project,

$$\frac{\partial C}{\partial t} = \frac{r + w\varepsilon + \delta}{(1-\theta)(1-t)^2} > 0$$

The first empirical objective of this study is to test all three implications of the theoretical model using data on firms from transition economies. In the next section, we use equation (3) to derive our empirical specification of firm innovation.

3. Methodology

Based on the theoretical model outlined in the previous section, the firm's innovation decision rule can be expressed by the distance between the expected return from innovation activity (R) and user cost of capital (C). If the distance between two factors is greater than zero, then the i th firm located in j th country in period t would find it profitable to pursue the new project associated with the adoption of new technology in its production process.

$$I_{ijt} = \begin{cases} 1 & \text{if } R_{ijt} - C_{ijt} \geq 0 \\ 0 & \text{if } R_{ijt} - C_{ijt} < 0 \end{cases} \quad (4)$$

After normalizing the expected return to zero and applying linearization to the user cost of capital given by expression (3) and substituting it with expression (4), the empirical specification of the firm's decision to innovate can be presented in the form of the propensity of firm innovation:

$$I_{ijt}^* = M_{jt}\boldsymbol{\mu} + F_{jt}\boldsymbol{\phi} + \delta A_i + \varepsilon_{ijt} \quad (5)$$

$$I_{ijt} = \begin{cases} 1 & \text{if } I_{ijt}^* \geq 0 \\ 0 & \text{if } I_{ijt}^* < 0 \end{cases}$$

In the above expression, the propensity to innovate is a function of the monetary policy instrument (M) given by the inflation adjusted interest rate and two fiscal policy instruments (F), such as the tax rate on corporation profit and the tax rate on personal income and capital gains. Taking into account heterogeneity in the development of monetary and fiscal policy institutions and differences in traditions and customs across transition economies, particularly in the Central Asian republics relative to other European transition economies, in our specification of firm innovation, we also add the dummy indicator that identifies the firms' location in the former region (A). We should note that the propensity of firm innovation is not observable, but what we really observe in each period is the firm's binary innovation decision. Taking into consideration that we observe the firm's innovation decision multiple times, the parameters of interest (μ and ϕ) can be estimated consistently and efficiently by the conventional random effect probit regression (*xtprobit* command in STATA), which allows us to control for intra-class correlation of firm innovation across time.

The empirical specification of firm innovation as given by expression (5) cannot be considered complete. If the regression is estimated as outlined by this expression, the main parameters of interest (μ , ϕ and δ) would be capturing the unobserved effects of other firm and country-level factors. Nevertheless, this simple specification of firm innovation enables us to quantify the role of monetary and fiscal policy regimes in the observed lag of firm innovation in the Central Asian republics. However, to separate the real effect of monetary and fiscal policy regimes from other firm and country-level factors and to gain a better understanding of all factors associated with the observed lag in firm innovation in the Central Asian republics, it is warranted to estimate a more complex specification of firm innovation. Specifically, in addition to variables in M , F and A , we should introduce a rich set of time-variant firm and country-level factors in the final specification of firm innovation. To manifest separately the contributions of the firm-level factors from the country-level factors, we follow a stepwise regression approach in which we estimate the series of multivariate regressions, adding to the existing set of controls – first, the new set of firm and then country-level variables.

4. Data

In this section, we first discuss the main sources of data used to construct dependent and independent variables in our empirical analyses of firm innovation. Then, we discuss trends in firm innovation and monetary and fiscal policy regimes separately for Central Asian and other transition economies. Finally, before reporting our results, we discuss the extent to which the variables used in our analysis are correlated with the propensity of firm innovation. The latter should help us motivate the use of multivariate regression analyses.

We use multiple sources of data to construct our analytical sample of firms that functioned in transition economies in the period between 2002 and 2009. Our analytical sample consists of detailed information on firms' involvement in innovative activities and a rich set of firm and country-level time-variant variables. Our main data source is the Business Environment and Enterprise Performance Survey (BEEPS) database, which is a joint initiative of the European Bank for Reconstruction and Development (EBRD) and the World Bank Group.³ The use of this

³ The first survey was undertaken in 1999–2000 covering approximately 4,000 enterprises from 26 countries of Central and Eastern Europe (CEE) and the Commonwealth of Independent States (CIS). The primary goal of the survey was to assess private enterprise and business development and its interaction with environment factors. Two years later, the second round of the BEEPS was conducted covering approximately 6,500 enterprises from 27 countries. Then, in 2005, the BEEPS instrument was administered to approximately 7,900 enterprises in the same 27

data source enabled us to obtain information on firm innovative activities and many essential firm-level characteristics for our analyses. It should be noted that the samples of firms included in the BEEPS are structured to represent the domestic economies, with specific quotas placed on firm size, sector, location, and export orientation. Furthermore, the samples are heavily weighted toward privately owned firms, but minimum quotas are used to ensure some representation of state-owned firms and firms with foreign ownership. Finally, the given survey contains rich information on the extent and nature of a firm's business activities, including questions on innovative activities, the level of local and national competition, and state intervention in firm decision making. For our empirical investigation, we use the last three waves of the BEEPS database that provide information on firms and their innovation behaviors for the period between 2002 and 2009 years.

Second, information on country-level characteristics is mainly drawn from the World Development Indicators (WDI) database. We merge information from this data source with the analytical sample of firms drawn from the BEEPS database. Unfortunately, in the WDI database, for some waves, data on monetary and fiscal policy instruments for certain countries are not reported due to unidentifiable reasons. To avoid the loss of the significant number of observations due to missing values for monetary and fiscal policy instruments for certain countries and years, we have made all attempts to identify the appropriate values using alternative data sources. Specifically, we use various country-level reports, briefs, or research papers issued by different local or international organizations or institutions to find the level of the interest rate, personal income and corporate taxation for countries and years not reported in the WDI database.

Further, we describe our dependent variable and firm and country-level independent variables used in our analyses. The list and detailed description of the variables are outlined in Table 1.

Dependent variable: The indicator of firm innovation is constructed using the question that determines whether the responding establishment has upgraded an existing product line or service. In deciding which measure of innovation to use in our analysis, we first surveyed the considerable amount of studies in the field of innovation. Most studies in the literature were related to firm innovation in developed/OECD countries. From the literature review, we find that many suggested measures of innovation are not directly applicable to firms located in developing/transition economies. For example, in developed countries, one of the frequently used indicators of firm innovation is the establishment-level information on the number of new patents granted each year. However, Aghion et al. (2002) discusses that patenting could be of less relevance to firms in transition economies. In fact, Ayyagari et al. (2011) make a case that innovation in countries located well inside the productivity frontier may consist of imitation and adaptation rather than the creation of new technologies. We believe that firms located in transition economies more likely operate within the productivity frontier. Therefore, the best indicator of firm innovation in transition economies can be whether the firm has introduced a new technology that substantially changes the way the main product is produced by this firm.

Firm-level independent variables: In our analyses, we also control for a rich set of firm-level characteristics. The establishment's size, legal status, age, and industry may have a direct impact on the firm's propensity to innovate. Furthermore, the presence of an internationally recognized quality certification and the use of modern information technologies in

communication with the clients can be a good indicator of firm's access and willingness to adopt new technologies and produce innovative products. Finally, the frequent experience of excessive power outages or losses as a result of various criminal actions of others should be a source of negative externalities, limiting the adoption of advanced technologies in the production process.

Table 1. List of Firm and Country-Level Variables Used in Analyses

Variable	Description	Type of Variable
<i>Dependent Variable</i>		
Innovation	In the last 3 years, this establishment upgraded an existing product line/service	Binary
<i>Firm-Level Independent Variables</i>		
Firm size	Size of the establishment: small, medium and large	Categorical
Public	Firm's current legal status is publicly listed company	Binary
Proprietorship	Firm's current legal status is sole proprietorship	Binary
Tenure in years	Years passed since establishment	Continuous
Quality certification	The firm has an internationally recognized quality certification	Binary
Power outages	Over the last fiscal year, the establishment experienced power outages	Binary
Use of email	The firm communicates with clients and suppliers by email	Binary
Use of website	The firm communicates with clients and suppliers via website	Binary
Criminal rate	In the last fiscal year, this establishment experienced losses as a result of theft, robbery, vandalism or arson	Binary
Private start-up	The firm was a private firm from the time of start-up	Binary
Industry	Firm's industry	Categorical
<i>Country-Level Variables</i>		
Real interest rate	The lending interest rate adjusted for inflation as measured by the GDP deflator	Continuous
Corporate tax rate	The total tax rate as a share of commercial profits after accounting for allowable deductions and exemptions	Continuous
Income tax rate	The tax rate on income, profits and capital gains	Continuous
GDP per capita	Gross Domestic Product/population (2000 US\$)	Continuous
Bank usage	% of firms using banks to finance investment	Continuous
Share of foreign banks	% of banks with assets of foreign ownership above 50%	Continuous
Labor force rate	% of total population ages 15-64 in labor force	Continuous
Research and development	% of GDP spent on research and development	Continuous
Internet users	Number of internet users per 100 people	Continuous

Country-level independent variables: The main independent variables in our empirical analyses are monetary and fiscal policy instruments. The lending interest rate adjusted for inflation as measured by the GDP deflator is used as the monetary policy instrument. The fiscal policy instruments are represented by the total tax rate on commercial profits after accounting for allowable deductions and exemptions and the tax rate on income, profits and capital gains. We believe that the first measure of fiscal policy approximates the instrument related to the corporate tax rate, while the second measure serves as a good proxy for the instrument representing the personal income tax rate. In our analyses, we also include a set of country-level variables that can

conceptually be correlated with either monetary or fiscal policy instruments or firm innovation. For example, excessive fluctuations in per capita gross domestic product or the labor force participation rate among the working-age population can be one of the drivers of constant changes in monetary and fiscal policy instruments. Changes in the financial and banking system through increases in a firm's willingness to use banks to finance its investment projects or substantial involvement of foreign banks in the provision of financial and banking services in the country may lead to changes in the level of firm innovation. Finally, firm innovation can be caused by changes in aggregate spending on research and development in the country and the level of popularization of the Internet among the general population.

As can be seen from Table 2, firms in transition economies are actively engaged in innovative activities. More than 52.2 percent of the firms in 2002, about 51 percent in 2005 and 74 percent in 2009 upgraded their existing product lines/services. As expected, the firms located in the Central Asian republics lag substantially in innovative activities compared to their counterparts from the European countries. For example, the differential in the propensity of firm innovation is around 5 percentage points in 2002, 11 percentage points in 2005 and 9 percentage points in 2009.

Table 2. Trends for Key Variables of Interest

Variable	All years	2002	2005	2009
Dependent Variable				
<i>Innovation:</i>				
All countries	60.10%	52.20%	51.00%	73.90%
Central Asia	52.90%	48.10%	40.90%	66.00%
Europe	61.30%	52.90%	52.70%	75.40%
Monetary and Fiscal Policy Instruments				
<i>Real interest rate:</i>				
All countries	7.70%	7.90%	4.60%	10.70%
Central Asia	8.30%	6.90%	11.00%	6.90%
Europe	7.60%	8.00%	3.50%	11.40%
<i>Corporate tax rate:</i>				
All countries	41.60%	23.60%	54.10%	46.20%
Central Asia	55.10%	25.30%	72.00%	68.20%
Europe	38.80%	23.30%	50.90%	42.20%
<i>Person income and capital gains tax rate:</i>				
All countries	24.30%	28.10%	24.70%	20.20%
Central Asia	20.60%	24.00%	20.00%	18.30%
Europe	25.00%	28.80%	25.60%	20.50%

The inflation adjusted interest rate fluctuated substantially in the study period. The average real interest rate declined from 7.9 percent to 4.6 percent between the years of 2002 and 2005, but then went up to 10.7 percent in 2009. The real interest rate behaved quite differently in the Central Asian republics compared to Eastern European transition economies. In the Central Asian republics, the real interest rate first increased from 6.9 percent to 11 percent between the years of 2002 and 2005 and then in 2009 it returned to the 2002 level.

The taxes levied on corporation profits fluctuated by almost 8 percentage points in the period between 2005 and 2009.⁴ As expected, the Central Asian republics have a higher tax rate on corporation profits compared to the Eastern European transition economies. Surprisingly, the tax rate on income, profits and capital gains is lower in the Central Asian republics compared to the other transition economies and it had declined from 25 percent in 2002 to 18 percent in 2009. However, the tax rate on income, profits and capital gains had also declined in Eastern European transition economies by the same margin from 29 percent in 2002 to 21 percent in 2009.

In Tables 3 and 4, we report descriptive statistics on firm and country-level variables by the indicator of firm innovation. Table 3 demonstrates that the propensity of firm innovation increases with the size and age of the establishment and with the use of advanced information technologies in communication with the clients. Furthermore, a typical firm involved in innovation activities is more likely to have currently and at the time of origination public legal status, be in the form of corporation or partnership, have foreign internationally recognized quality certification and be a part of the manufacturing industry. Surprisingly, the firms experiencing the higher level of unexpected electric power outages or losses due to robbery, theft or vandalism are more likely to be involved in innovative activities.

Table 3. Descriptive Statistics on Key Firm-Level Variables by Outcome

	Not to Innovate	Innovate
Firm size: Small (<20 employees)	57.34%	37.92%
Medium (20-99 employees)	26.06%	33.86%
Large (over 100 employees)	16.60%	26.42%
Sole proprietorship	33.13%	22.48%
Public	4.85%	8.37%
Tenure in years	14.77	16.42
Quality certification	10.40%	22.48%
Any electrical power outages	40.63%	43.59%
Communicate via email	55.07%	74.80%
Communicate via website	46.71%	61.90%
Any losses due to robbery, etc.	20.30%	25.96%
Private start-up	75.86%	72.30%
Industry: Manufacturing	28.63%	43.04%
Sales	32.47%	26.37%
Services	27.29%	20.87%
Construction	11.61%	9.72%

With respect to country-level characteristics, Table 4 demonstrates that firm innovation may increase with the real interest rate and decrease with the tax rate on income, profits and capital gains. Furthermore, firm innovation can be higher in the countries with the higher

⁴ It should be noted that information on the total tax rate as a share of commercial profits after accounting for allowable deductions and exemptions for any of transition economies in 2002 wasn't reported in the WDI database. Therefore, we use the actual corporate tax rate reported in various reports, briefs and research papers.

percentage of firms lending from banks to pursue their investment projects, the higher level of public and private spending on research and development of new technologies and the larger number of Internet users among the general population. The mean statistics for other country-level variables do not qualitatively differ by the innovation decision of firms.

Table 4. Descriptive Statistics on Key Country-Level Variables by Outcome

	Not to Innovate	Innovate
<i>Monetary & Fiscal Policy Instruments</i>		
Real interest rate	6.54	7.82
Corporate tax rate	43.72	44.1
Personal income and capital gains tax rate	25.58	22.87
<i>Country-Level Characteristics</i>		
GDP per capita (in \$1,000)	2.96	3.01
% of firms using banks to invest	25.08%	29.07%
Share of foreign banks	51.56%	52.81%
Labor force participation rate	66.28%	66.70%
Research and development	65.90%	69.41%
Internet users	22.24%	25.17%

5. Results

The main objectives of this study are twofold. The first objective is to understand how a monetary policy instrument, such as the inflation adjusted interest rate along with two fiscal policy instruments representing the average tax rate on corporation profits and on income and capital gains, impact the innovation behavior of the typical firm in the transition economy. The second objective of this study is to gain a better understanding of the extent to which the differences in firm-level and country-level characteristics explain the observed lag in firm innovation in Central Asian republics. To address both objectives, we carry out a series of multivariate regression analyses. In Table 5, we present the marginal effects from different multivariate regressions of the four main variables of interest such as monetary and fiscal policy instruments and an indicator of firms representing the Central Asian republics. Specifically, in this table, we present findings from baseline model and four different specifications of firm innovation. The baseline model presents the result from unadjusted regression of firm innovation on the Central Asian republic dummy. In the first model, we add monetary and fiscal policy instruments to the baseline model; in the second model, we enhance the model with industry dummies as controls for the primary variables of interest; in the third model, along with industry dummies, we introduce a set of firm-level characteristics; in the final specification, we finally introduce a set of country-level variables. Such a stepwise approach helps us shed a light on the contributions of various factors on the observed lag in firm innovation for the Central Asian republics and observe how the effect of monetary and fiscal policy instruments change with additional controls.

Table 5. Marginal effects estimated at means for the key variable of interest (dynamic probit model with the indicator of firm innovation as a dependent variable)

Variable	Baseline	Model 1	Model 2	Model 3	Model 4
Real Interest Rate		0.511*** (0.038)	0.478*** (0.038)	0.559*** (0.040)	0.523*** (0.044)
Corporate Tax Rate		0.083*** (0.016)	0.064*** (0.016)	0.069*** (0.016)	- 0.091*** (0.022)
Personal Income and Capital Gains Tax Rate		-0.531*** (0.027)	- 0.522*** (0.027)	-0.502*** (0.029)	- 0.278*** (0.040)
Central Asian Republics	-0.083*** (0.009)	-0.115*** (0.009)	- 0.112*** (0.009)	-0.053*** (0.010)	-0.001 (0.014)
Industry	No	No	Yes	Yes	Yes
Firm-Level Characteristics	No	No	No	Yes	Yes
Country-Level Characteristics	No	No	No	No	Yes

Number of observations in each regression is 24,661 firm x year. Number of unique firms is 21,476 and maximum number of periods for any firm is 3 periods. In the parenthesis, we report standard errors computed using the delta-method.

We find that holding all else equal, an increase in the inflation adjusted interest rate substantially increases the propensity of firm innovation. In particular, a 1 percentage point increase in the real interest rate increases the propensity of firm innovation by 0.5 percentage points (in this paragraph we use results corresponding to Model 4 in Table 5). This finding acts in contradiction to the existing literature, where an overall negative effect of rising interest rates on innovative activities is well documented (Hall, 1992; Himmelberg and Peterson, 1994; Evers et al., 2007; Chu and Lai, 2013).

At the same time, the results show that both fiscal policy instruments are negatively associated with firm innovation, which goes along with predictions of the theoretical model. Holding all else equal, a 1 percentage point increase in taxes levied on corporation profits decreases the propensity of innovation by 0.09 percentage points. However, the effect of taxes on income, profits and capital gains is much higher: a 1 percentage point increase in these types of taxes decreases the propensity of firm innovation by 0.29 percentage points.

Comparing the unadjusted gap in the propensity of firm innovation in Central Asian republics and the Eastern European transitional economies reported in the first column of Table 5 with the similar estimate after adjusting for differences in monetary and fiscal policy instruments (See Model 1 in Table 5), we can conclude that the monetary policy and two fiscal policy instruments may moderately impact the lag in firm innovation in the Central Asian republics. The gap in the baseline model is 8.4 percentage points, while it increases to the 11.5 percentage points after accounting for differences in monetary and fiscal policy regimes. This finding provides some evidence that monetary and fiscal policy regimes in the Central Asian republics can be conducive to firm innovation compared with European transition economies.

The additional control for industry dummies does not significantly change the differential in firm innovation between two types of transition economies. However, after controlling for firm-level characteristics, the gap has decreased by more than a factor of two (see the results corresponding to Model 3 in Table 5), reducing to 5.3 percentage points. Furthermore, after

controlling for country-level variables, disparity in the propensity of firm innovation between Central Asian and Eastern European transition economies has completely disappeared, implying that both firm and country-level variables explain the current gap in firm innovation in Central Asian republics.

In the next section, we discuss policy implications of our results and then we provide policy recommendations for the Central Asian republics on ways to bring the level of firm innovation to the level of European transition economies.

6. Conclusion and Policy Implications

The main conceptual issue that guided our theoretical and empirical investigations is related to a supplementary relationship between monetary and fiscal policy instruments. In the investigation of the effectiveness of monetary policy instruments in firm innovation, it is important to account for any changes in fiscal policy regimes that take place simultaneously with monetary policy regimes. It is a well-known fact that changes in monetary policy instruments could be accompanied by changes in fiscal policy instruments and vice versa (Feldstein, 1998). For example, to speed up the process of adopting new technologies in an economy, the monetary authority may slash its interest rate (monetary policy instrument), but at the same time, the fiscal authority may reduce the corporate tax rate, introduce investment tax credits or allow taking depreciation allowances greater than the true economic depreciation (fiscal policy instruments). A failure to account for changes in fiscal policy regimes in firm innovation decisions may substantially bias the parameters of monetary policy instruments, leading to erroneous policy inferences and conclusions. Therefore, in our study, along with a single monetary instrument like a real interest rate, we introduced two fiscal policy instruments, such as a tax rate on personal income, profits and capital gains and a tax rate on corporation profits to gain a better understanding of the way both monetary and fiscal policy regimes affect the innovation decisions of firms.

The most provocative result of this study is the fact that an increase in the inflation adjusted interest rate may increase firm innovation. According to the principles of economics, the higher the interest rate, the more expensive borrowing becomes. The increase in the opportunity cost of own or external equities due to an increase in the real interest rate leads to a situation in which a typical firm is less willing to be involved in any activities related to the acquisition of new investment or innovative goods. In contrast to conventional wisdom, our results show that at the time of the high real interest rate, firms in transition economies may have a stronger preference toward the adoption of new technologies.

We provide the following several explanations for this, which is quite a provocative finding. First, the real interest rate constitutes the difference between the nominal interest rate and actual inflation. The low value of the real interest rate reflects either the period of high inflation or the period of the low nominal interest rate. In transition economies, the nominal interest rate in many situations is substantially higher than in developed economies. So, an increase in the real interest rate probably constitutes the period of relatively low actual inflation. This implies that the positive relationship between the real interest rate and firm innovation is mainly driven by the stabilized inflation rate by monetary authorities. The establishments in the period of more predictable inflation may have a higher preference for new innovative projects due to the positive expectation about the economic development of the country. Otherwise, firms might see rising interest rates as a sign of strengthening the economy and an acceleration of economic activity.

Firms become more confident that growth will be solid in the years ahead. As a result, improved business confidence encourages and supports firms' interest in innovation.

Another explanation for this contradictory result has to do with the peculiarity of the financial system in transition economies, specifically in Central Asian republics. Firms in these countries may have strong preference for cash holdings over bank deposits due to either a lack of trust of financial authorities or as precautionary measures. Therefore, for such firms, the link between the price of capital and firm innovative effort may be reversed.

We also find that an increase in the tax rate for corporation profits or income, profits and capital gains increases firm innovation. Holding all else equal, low personal or corporate tax rates reduce the rate of return that the new investment project must attain to be considered as profitable. This increases the chance that firm will pursue the innovative project. Surprisingly, we find that the tax rate on personal income and capital gains has a higher impact on firm innovation than the tax rate on corporation profits. The relative higher sensitivity of firm innovation to personal income taxation compared to corporate taxation points toward the fact that many establishments in transition economies are owned by a single individual or small group of individuals. Therefore, in the case of the low personal income tax rate, the double taxation issue is not a constraint in the investment decision-making process and owners are willing to channel more financial resources for the acquisition of new fixed assets. Overall, these findings are consistent with those in the Fazzari et al. (1988) study that demonstrates the sensitivity of firm investment to changes in tax rates.

Our results show that current monetary and fiscal policy regimes in the Central Asian republics can be conducive to firm innovation. If these republics have adopted the similar monetary and fiscal policy as in the European transition economies, the gap in firm innovation would be much wider. Further, after controlling for a rich set of firm and country-level factors, an 11 percentage point differential in firm innovation for firms located in the Central Asian republics completely disappears. The stepwise analyses (adding each variable at a time), which we only partially report in this paper,⁵ shows that a 5 percentage point differential can be explained by differences in the communication with clients and suppliers via email and websites. The establishments located in the Central Asian republics substantially lag their counterparts located in the European countries in communication with their clients and suppliers via web or email by more than 30 percentage points. Another 4 percentage point differential in firm innovation for the Central Asian republics is explained by the number of Internet users for 100 individuals in those republics. The Central Asian republics lag the European transition economies in the rate of popularization of Internet by a factor of more than three. Also, the roughly 1.5 percentage point gap in firm innovation for the Central Asian republics is explained by the lag in aggregate spending on research and development activities. The Central Asian republics spend four times less on research and development of new technologies. Finally, establishments in the Central Asian republics are two times less likely to borrow from financial institutions to finance new investment projects, leading to a 1 percentage point differential in firm innovation.

Combining the findings together, the level of firm innovation set by the European transition economies seems to be very achievable for the Central Asian republics. The government of these republics should simply eliminate any barriers to Internet access; subsidize the use of advanced information technologies in the communication process with clients and suppliers, probably through the provision of tax incentives for any expenses related to Internet services; improve

⁵ Upon a separate request, full analyses will be provided by the authors.

financial services provided by commercial banks; and increase either direct public spending on research and development activities or provide additional tax incentives for firms involved in such activities.

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