economies

MDPI

Article

Understanding Imbalanced Transmission from R&D Inputs into Innovation Outputs and Impacts: Evidence from Kazakhstan

Stefka Slavova [1], Luis Rubalcaba [2,*] and José Nicanor Franco-Riquelme [3]

1 Finance, Competitiveness and Investment Global Practice, Europe and Central Asia Region, The World Bank, Washington, DC 20037, USA; sslavova@worldbank.org
2 Department of Economics and Business Administration, University of Alcala, 28801 Alcalá de Henares, Madrid, Spain
3 Department of Organization Engineering, Business Administration and Statistics, Universidad Politécnica de Madrid, 28006 Madrid, Spain; j.franco.riquelme@upm.es
* Correspondence: luis.rubalcaba@uah.es

Abstract: Innovation ecosystems use R&D inputs to generate innovation outputs first and innovation impacts later. But some countries show a relatively low transmission, such as in the case of Kazakhstan, the largest economy in Central Asia. This article analyzes the transmission from R&D into innovation outputs and impacts through a framework for which different factors matter, such as the company size, education and skills, competition, exports, and foreign ownership. Transmission is conceptually understood in two steps: from R&D into innovation outputs, and from innovation output into innovation impacts. The main hypothesis is that the high endowments of these company factors should lead to the better transmission of results and improved performance in terms of outputs and impacts. We test this using new evidence from Kazakhstan and the ECA region (Europe and Central as defined by the World Bank) as benchmarking, and data are from the Global Innovation Index (descriptive section) and the World Bank Enterprise Surveys (analytical section). The econometrics are a Crépon–Duguet–Mairesse (CDM) model in three steps: factors for propensity to invest in R&D, then to innovate, and, finally, innovation impacts on productivity. Results confirm the positive roles of factors, such as exports and education, in positive transmissions and uneven or insignificant results on productivity impacts from characteristics, such as age, size, and foreign ownership. The specifics for Kazakhstan suggest a potential for business innovation growth in the country. The paper concludes by suggesting key policy measures to unlock the potential for business innovation at a country level.

Keywords: R&D; innovation; CDM model; linear regression; Kazakhstan

check for updates

Academic Editor: Sanzidur Rahman

Received: 24 October 2024
Revised: 10 January 2025
Accepted: 16 January 2025
Published: 22 January 2025

Citation: Slavova, S., Rubalcaba, L., & Franco-Riquelme, J. N. (2025). Understanding Imbalanced Transmission from R&D Inputs into Innovation Outputs and Impacts: Evidence from Kazakhstan. *Economies*, *13*(2), 25. https://doi.org/10.3390/economies13020025

Copyright: © 2025 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

1. Introduction

Innovation plays an essential role in the economic development of a country. It can help promote an understanding of potential development pathways in developing countries (Lema et al., 2018) by focusing on innovation policies that ensure the benefits of participating in global value chains and how innovation systems in countries and sectors co-evolve to promote learning and innovation. Certain studies (Galindo & Méndez-Picazo, 2013; Maradana et al., 2017) suggest that a country's ability to keep pace with market developments is a key driver of economic growth and human well-being, contributing to economic growth.

Governments and organizations seek to increase employment and revenue through innovation. Strengthening trust in institutions and avoiding politically uncertain systems are essential factors for business growth, along with the ability to innovate (Jardon & Martinez-Cobas, 2022). Developing countries need to learn from the experiences of dynamic economies and the best policy practices when formulating policies to promote innovation. While essential for innovation, local knowledge spillovers are not sufficient for economic success, and the business environment must be connected to the local and international economy (Kesidou & Szirmai, 2008). In this sense, innovation policy interfaces with research, technological development, and industrial policy to create a favorable framework for implementing ideas that build on some economic regions. Indeed, it requires action in many policy areas: education, trade, investment, and finance, and the diversity of interventions in these different disciplines represents an advantageous innovation climate (World Bank, 2010).

Previous research in different countries shows the importance of business innovation in increasing productivity and growth (Rubalcaba et al., 2017). Productivity means the conversion of factors of production (capital and labor) into outputs and is a key driver of growth. The literature has rarely addressed the main components of economic growth, such as the total factor productivity (TFP) and capital accumulation (growth of capital stock), which can be accelerated or slowed by financial integration. In their study, (Guru & Yadav, 2021) found that capital accumulation is as important to Asia's macroeconomic growth as TFP growth.

In this work, we focus on Kazakhstan, the largest economy in Central Asia. The country has extensive natural resources and is highly dependent on revenues from the export of commodities, particularly petroleum, which contributed 23.7% to the country's gross domestic product (GDP) at its peak in 2005 and stood at 15.56% in 2018 (World Bank Group, 2019, 2020). In this sense, economic diversification is critical, as dependence on commodities alone will not produce the long-term growth needed (Asian Development Bank, 2017). Therefore, the country's growth is heavily dependent on the expansion of energy production, and the petroleum sector has enabled a rapid increase in domestic savings and demand. This adversely affects other industries and the private sector's overall development.

Evidence suggests that Kazakhstan experienced strong productivity growth in the early 2000s, contributing to average annual GDP growth of 6% (World Bank, 2019); yet, it has declined steadily over the past decade, and productivity stagnation is a serious concern (World Bank Group, 2019, 2020). Moreover, declining within-sector and within-firm productivity is the driving force behind the slowdown in productivity in this country. Consequently, technology development, innovation strategies, and diversification activities are essential to support the country's economic growth, including technological upgrades, capability improvements, and innovation at the enterprise level. In this context, R&D investments are a key factor in boosting innovation outputs and impacts on productivity.

This paper will show the relatively high level of R&D and innovation inputs in Kazakhstan, while the innovation outputs are low and declining. The imbalanced transmission from R&D inputs to innovation outputs in Kazakhstan involves a complex issue influenced by various factors, such as the necessity for a better alignment among education, industry, and science to enhance the impact of research on economic growth (Ilmaliyev et al., 2022). For this, we need to add the state's role in promoting R&D results and creating a national innovation system (Mukhtarova et al., 2017). However, the impact of R&D expenditures on economic growth is limited, suggesting a need for the more effective allocation of resources (Manatovna et al., 2023).

The diffusion of innovation, a central phenomenon to innovation studies, encapsulates how a novel idea, technology, or practice spreads across individuals, organizations, or societies. Furthermore, knowledge spillovers are crucial to reducing inequality in innovation activity and stimulating economic growth. Rogers et al. (2014) define innovation diffusion as the spread of innovations through specific channels and to a particular time in a social system. According to Mahajan (2010), diffusion comprises four key elements: innovation, communication channels, time, and the social system. Therefore, to adapt to a model that includes inputs and outputs, we should understand the factors contributing to generating impacts in various contexts; to this end, it is essential to develop a conceptual framework. In investigating the dynamics of the diffusion of innovations, a conceptual model could be set to discern the nuanced interplay between critical explanatory factors and their potential impact on generating outputs and subsequent effects. The conceptualization revolves around crucial variables, such as the company size, education and skills, competition, exports, and the foreign ownership sector. In addition, innovation statistics include variables, including these factors among many others (Gault, 2018).

Our work is driven by two research questions: as Kazakhstan has relatively many inputs and not that many outputs, is there a problem in converting inputs into outputs and outputs into impacts? If so, what factors may influence such an imbalance in transmissions generating innovation outputs and innovation impacts? To answer the question, we based it on R&D, innovation, and productivity data—but this relationship is not always direct, and there may be feedback loops between the three indicators—to examine it at a country level. A key hypothesis is that based on the existing literature, the lack of a good transmission may be related to specific factors linked to the business characteristics of Kazakhstan companies. Then, with the help of an econometric model, it is possible to observe the relationships among R&D, outputs, and impacts as is performed in the Crépon–Duguet–Mairesse (CDM) model (Crépon et al., 1998) that we follow in this paper. Beyond the empirical work, the paper also suggests some policy implications.

This paper contributes to the existing literature by analyzing the relationship among inputs, outputs, and impacts based on the CDM model (Crépon et al., 1998) in a major developing economy, Kazakhstan, where the endeavors of inputs and outputs are heavily imbalanced. Furthermore, it integrates company explanatory factors that may mediate such transmissions and identifies gaps in one country concerning its comparator region. Finally, this paper suggests business innovation policies may be highly important for improving positive transmission from inputs into outputs and impacts.

This paper proceeds as follows. Section 2 reviews the relevant literature, exploring innovation concepts and econometric modeling. Section 3 describes the methodological approach. Section 4 presents empirical findings and data to find the significant strengths and weaknesses of the firms' environment and explore the innovation factors that drive firm performance in the country. Section 5 discusses the implications of innovation policy and the final remarks on the country's outlook.

2. Literature Review and Conceptual Framework

2.1. Background

The core of the empirical work is based on the CDM econometric modeling in which the authors proposed a three-stage structural model that estimates the impact on the relationship among R&D, innovation outputs, and productivity at the firm level. This model has provided empirical evidence tested in different contexts and countries (Bartelsman et al., 2016; Castellacci, 2011; Crépon et al., 1998; Crespi et al., 2016; Lööf, 2005; Rubalcaba & Deschryvere, 2022).

The CDM model represents a structural instance that explains productivity through innovation output and the latter through research investment (Lööf, 2005; Lööf et al., 2017). The goal is to correct for the selectivity and endogeneity inherent to the model. Although there are other alternatives to the CDM model, it is not only widely used but has been used in similar studies on small entrepreneurial firms, manufacturing, and environmental innovation in developing countries (Crespi & Zuniga, 2012; Edeh & Acedo, 2021; García-Pozo et al., 2018; Leiponen, 2012).

Extensive literature establishes a link between R&D investment and innovation performance at the firm level and firm performance measured based on firm productivity. The CDM model analyzes the different stages of the innovation process, rather than examining the impact of R&D investment on firm productivity performance based on the knowledge production function approach (Griliches, 1979a, 1979b). In competitive industries, innovation inputs have a significant impact on firms' technological and economic performance (Castellacci, 2011). However, Mansury and Love (2008) found a positive effect of service innovation on growth, not productivity, in the U.S. business services firms. Moreover, Lööf (2005) pointed out that the differences between services and manufacturing are not substantial. Concerning European economies, Crowley and McCann (2018) found that innovation is associated with productivity gains in many sectors and environments, although innovators are not necessarily more productive. Capital investment, size, and location are three factors observed by innovators.

The CDM model could be implemented through extensive data, such as public indexes. A good example, the World Bank Enterprise Surveys (WBESs) are a tool to collect comparable firm-level information and to enable policymakers to implement improvements in the business environment. The WBES includes a broad range of business environment topics, such as access to finance, corruption, infrastructure, crime, and competition and covers firm performance measures, as well as firms' innovation performance. It consists of a firm-level survey of a representative sample of an economy's private sector and has been conducted since 2002 by the World Bank. The WBES helps policymakers recognize, prioritize, and execute policy improvements and institutions that support effective private economic activity.

At another level, the use of econometric models has been established in the case of developing countries. The study of Waheed (2017), found that firm size (measured based on sales) is a significant determinant of R&D in Bangladeshi firms and the probability of process innovation, using a combination of the CDM model and WBES data. Nevertheless, there is no significant correlation between sales and product innovation. Other scholars (Younas & ul Husnain, 2022) were able to use the CDM model to examine the impact of industry-level competition on the relationship between innovation and productivity in Pakistani manufacturing firms. Using Colombian firm-level data, another study (Ramírez et al., 2019) examined the relationship among human capital, R&D investment, innovation, and productivity by estimating three different versions of the CDM model that included human capital. Their goal was to control the endogeneity created by adding this variable so that human capital is a causal factor in R&D investment decisions, innovation behavior, and labor productivity growth. Using a sequential structural econometric model using the Eurostat collection of Community Innovation Surveys, Foreman-Peck and Zhou (2022) estimated the effects of R&D subsidy policies at the firm level and on the economies of Eastern European countries and the European Union (EU). They found an inverse relationship between the impact of the EU and national innovation policies in the old and new EU members. For the former, the impact of national policies was more significant than that of the EU. For the latter, EU innovation policy impacts were more notable than national impacts, suggesting that large external EU-funded innovation initiatives are crowding out national innovation initiatives.

According to certain innovation studies (Cirera & Maloney, 2017; Lazonick & Mazzucato, 2013), the returns to innovation investment are expected to be particularly high in developing countries. Nevertheless, there is a high degree of uncertainty. While there is a nonlinear relationship between productive capacity accumulation and high innovation intensity, as noted by Fedyunina and Radosevic (2022), they suggest that the CDM model and its modified versions paint an inaccurate picture of technological upgrading in emerging economies that does not reflect the stylized facts of innovation in these economies. In contrast, an adaptation of the CDM model (Crespi et al., 2016; Crespi & Zuniga, 2012) summarizes its application with the firm's decision to invest or not in innovation activities and, if it chooses to do so, with what intensity. Then, these activities are expected to generate new knowledge or innovations. Finally, innovative firms should increase productivity, reduce costs, and improve the quality of their goods and services. Innovation investments would lead them to gain market share and thus displace non-innovative firms.

Regarding the implementation of linear models and the specific case of linear regression, it plays a fundamental role in statistical modeling that could be a helpful option to put a determinate country in context. In the regression analysis, mathematical models are constructed that describe or explain relationships between variables (Seber & Lee, 2003). Hence, the linear regression method predicts the outcome of a future event by establishing a linear relationship between an independent variable and a dependent variable (Su et al., 2012). In this case, with the help of linear regression, it is possible to observe the different results based on the comparison of certain countries.

In order to implement our linear models, we assess innovation at a country level based on the Global Innovation Index (GII). This index is published by Cornell University, the European Institute for Business Administration (INSEAD), and the World Intellectual Property Organization (WIPO) annually (Cornell University et al., 2020). These Institutions rank economies using many different variables in different qualities. Launched in 2007, the Annual GII Report has a simple goal of determining how to find metrics and approaches that best capture the richness of innovation in society and, consequently, go beyond conventional measures of innovation, such as the number of research articles and the costs incurred in support of research and development (R&D).

2.2. Conceptual Framework

The diffusion of innovation is an underlying phenomenon of innovation studies that encapsulates the phenomenon of the spreading of a novel idea, technology, or practice across individuals, organizations, or societies (Mahajan, 2010; Rogers et al., 2014). The theory is increasingly applied to new areas, and the modified diffusion models can provide theoretical guidance for the diffusion of new products and services (Ying & Mengqing, 2011). In the context of investigating the dynamics of innovation transmission, a conceptual framework is developed to discern the interplay between critical explanatory factors and their potential impact on generating outputs and subsequent impacts (Wejnert, 2003). The conceptualization revolves around critical variables: company size, education and skills, competition, exports, and the foreign ownership sector.

To propose a comprehensive framework for elucidating the linkages between R&D investment and productivity at the firm level, adaptation of the CDM model (Crépon et al., 1998) to a broader national framework is critical. Moreover, adaptation to the country level requires the careful consideration of macroeconomic nuances, data-related challenges, and broader policy implications. Such adaptations can provide invaluable insights into the role of R&D in developing the national economy. The resulting model provides an estimate of the input and output additionality effects of a given country, mainly whether the effects of the other factors (e.g., technology) provide specific context with available data for a better understanding.

The given framework posits that the company size may determine innovation capabilities, with larger firms potentially possessing more significant resources for research and development activities. Additionally, the education and skills of the workforce are posited as instrumental in fostering innovation, where higher levels are expected to correlate positively with enhanced innovative capacity. Furthermore, the market competition level is theorized to influence firms' impetus for innovation, with heightened competition likely to stimulate greater investment in research and development. In the global context, the framework considers the impact of export activities on innovation, postulating that companies engaged in international trade may be motivated to innovate to meet global standards. In short, the foreign ownership sector is incorporated, suggesting that companies with foreign ownership may bring diverse expertise and resources that could catalyze innovation. This conceptual framework aims to elucidate the multifaceted relationships among these factors and their potential implications for generating outputs and consequential impacts within the innovation landscape. Figure 1 below represents the conceptual framework.

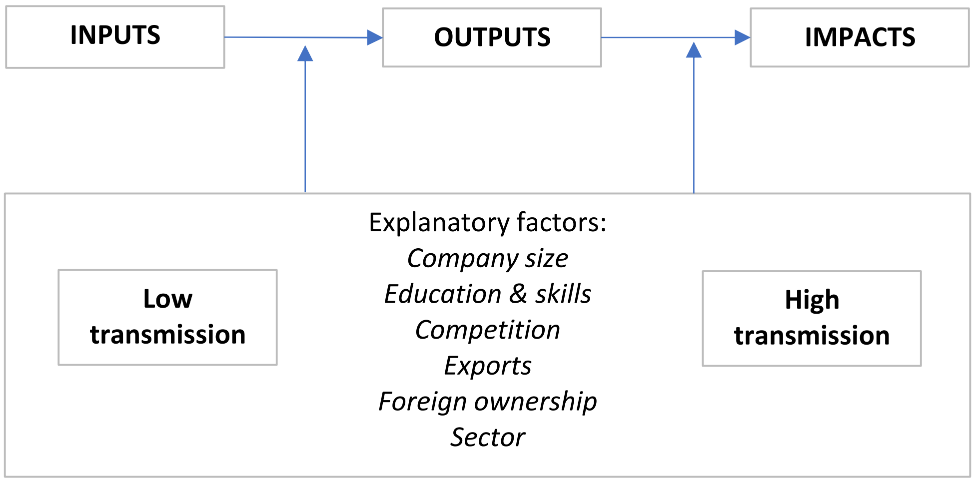

Figure 1. Dynamics of a two-step transmission from innovation inputs into outputs and impacts.

This framework provides a structured basis for an empirical investigation, aiming to unravel the intricacies of the innovation dynamics in Kazakhstan and shed light on the underlying factors hindering the efficient conversion of inputs into outputs and, subsequently, outputs into impactful outcomes. Low transmission is defined as a relative endowment of inputs higher than the relative endowment of outputs (more is less; efficient use of the R&D investment in particular). High transmission is when inputs perform relatively worse than outputs (less is more; not efficient use of R&D investment in particular). The fact that some countries can do more with fewer resources indicates that the quality of such inputs is higher than that in the opposite case. For example, little R&D but the ability to generate many patents and produce innovation impacting productivity is, *ceteris paribus*, a sign of the powerful endowment of R&D. Much R&D investment with little impact would be a sign of poor R&D performance.

2.3. Objective, Research Questions, and Hypotheses

As stated in the introduction, the goal of this paper is to better understand the transmission from R&D into innovation outputs and from these outputs into innovation impacts. For this, the case of Kazakhstan is analyzed under these research questions previously stated in the introduction: as Kazakhstan has relatively many inputs and not that many outputs, is there a problem in converting inputs into outputs and outputs into impacts? If so, what factors may influence such imbalances in transmissions generating innovation outputs and innovation impacts? A key hypothesis is that, based on existing literature, the lack of a good transmission may be related to specific factors linked to the business characteristics of Kazakhstan companies. Of course, this is a very particular and limited focus within the whole set of factors that influence innovation transmission, linked to the process of innovation diffusion in terms of the communication channels, time, and social and system theories. We focus on the company factors as these allow for a correct focus on a very complex issue and capture what is available to measure using the WBES data.

Derived from this goal and RQs, we formulated the following three detailed hypotheses:

H1: *R&D generates positive effects on outputs in Kazakhstan but less than in Europe and Central Asia (ECA) regions because the inputs are less advanced.*

In Kazakhstan's R&D activities, there is a noticeable discrepancy where the positive effects on innovation outputs are not as significant as those observed in the ECA region. This disparity is due to the less advanced nature of the inputs integral to the R&D processes in Kazakhstan (Audretsch & Belitski, 2020). The scientific community posits that the effectiveness of R&D efforts is closely linked to the sophistication of the foundational inputs, including the technological infrastructure, human capital, and institutional frameworks. Compared to the ECA region, Kazakhstan's R&D inputs appear less developed, reducing the potential positive impact on innovation outputs (Lau et al., 2015).

H2: *Innovation outputs generate positive impacts on productivity in Kazakhstan.*

The examination of innovation dynamics in Kazakhstan reveals a remarkable tendency in which the beneficial effects of innovation outputs are considerably less significant than those observed in the ECA region (Cornell University et al., 2020). As a result, the transformational potential of innovation output depends on a country's level of innovation sophistication and technological advancement. In this context, Kazakhstan's ranking as the least advanced innovator indicates a relative lag in implementing and digesting creative solutions, limiting the magnitude of positive consequences (Manatovna et al., 2023). This observation underscores the imperative for a targeted investigation into the determinants contributing to Kazakhstan's positioning as the least advanced innovator, fostering a deeper understanding of the intricate linkages between innovation outputs and ensuing impacts within the regional and global innovation landscape.

H3: *Company size, education and skills, competition, exports, and the foreign ownership sector significantly influence the imbalance in converting innovation outputs into impacts in Kazakhstan.*

The analysis of Kazakhstan's complex landscape of innovation dynamics reveals that the dimensions of the company size, education and skills, competition, exports, and foreign ownership sector significantly influence the observed imbalance in converting innovation outputs into impacts. The first factor to consider is company size. Research has shown that larger companies often have more resources and capabilities, which can positively impact their business performance (Ravichandran & Lertwongsatien, 2005; Uhlaner et al., 2013). Additionally, the level of education and skills among employees can play a significant role in determining the success of a business (Agbim, 2013). Well-educated and skilled workers are more likely to contribute to innovation and productivity, leading to better outcomes.

Moreover, competition in the market also plays a crucial role in shaping business outcomes (Nenonen et al., 2019). The level of competition can impact the pricing strategies, market share, and overall profitability. Businesses need to understand their competitive landscape and adapt their strategies accordingly.

Furthermore, the influence of exports on business performance should not be overlooked. For businesses engaged in international trade, exports can lead to increased revenue, expanded market reach, and access to new opportunities (Leonidou et al., 2007).

The ability to effectively navigate the complexities of international markets and adapt to cultural differences can greatly impact the success of a business.

Another factor to consider is the foreign ownership sector. Businesses that have foreign ownership may face unique challenges and opportunities. Foreign ownership can bring access to international networks, capital, and expertise, positively impacting business outcomes (Yiu et al., 2007). However, it is important for businesses to consider the potential risks and challenges associated with foreign ownership, such as cultural barriers, regulatory differences, and political instability.

3. Data and Methods

In this section, we combine two data sources, the GII and WBES, to explain our analysis of Kazakhstan's innovation situation relative to other economies and to apply a preliminary descriptive approach (GII) and the chosen econometric approach, the CDM model (WBES).

3.1. GII Characteristics

GII reveals the characteristics of the components of creative intangible assets and differs from other indices that measure innovation globally (Cornell University et al., 2020). GII aims to capture the multidimensional facets of innovation and provide the tools that can assist in tailoring policies to promote long-term output growth, improved productivity, and job growth. Due to its characteristics, GII can be a leading source of intangible asset-related innovation for scholars, business executives, and policymakers (Sohn et al., 2015) and is recognized due to its leading reference in innovation and relevance. Thus, it has provided a holistic framework for measuring innovation, and its indicators explore a broad vision of linked subjects, including the policy environment, education, infrastructure, and business sophistication.

There are five pillars describing innovation attributes, each including up to five indicators, for which scores are calculated based on weighted averages. The GII methodology defines an innovation input as the simple average of the first five pillar scores and captures the elements of the national economy that enable innovative activities. These five pillars include the following: Institutions (3 sub-pillars: political environment, regulatory environment, business environment); Human capital and research (3 sub-pillars: education, tertiary education, research and development); Infrastructure (3 sub-pillars: ICT, energy, general infrastructure); Market sophistication (3 sub-pillars: credit, investment, trade and competition); and Business sophistication (3 sub-pillars: knowledge workers, innovation linkages, knowledge absorption). The Innovation outputs index is the simple average of the scores based on the following two pillars, designed to capture the results and actual evidence of innovation activity: knowledge and technology outputs (3 sub-pillars: knowledge creation, knowledge impact, knowledge diffusion) and creative outputs (2 sub-pillars: creative intangibles, creative goods, and services outputs).

To perform our comparison, we implemented a linear model to describe a continuous response variable as a function of one or more predictor variables, in this case, the GII score over the years. Linear regression (Seber & Lee, 2003; Su et al., 2012) is a statistical method used to create a linear model. Hence, we considered that innovation in Kazakhstan can be analyzed by comparing its performance with that of ten economies: regional peers and global innovation leaders. To this end and to provide a broader overview of the Kazakh economy that is the subject of this study, we selected Switzerland, China, Chile, Russia, India, Azerbaijan, Kyrgyzstan, Tajikistan, and Uzbekistan (due to the lack of GII data for Uzbekistan between 2016 and 2019, we have replaced the missing values with the mean score for 2015 and 2020) as comparator countries; these economies represent the global innovation leader (Switzerland), the leading neighbor (Russia), and other Central Asian economies. We also include China as the innovation leader in the upper middle-income group, India as another regional leader in South Asia, and Chile as the innovation leader in South America. In this way, we reviewed the innovation performance of each country over time and the impact of investment in innovation inputs on innovation outputs.

3.2. WBES Characteristics

As a nationally representative survey of top managers and business owners in more than 150 economies, the WBES provides insights into access to finance, corruption, infrastructure, and performance among other business environment topics. It is conducted by the World Bank Group and its partners across all geographic regions and covers small, medium, and large firms (see https://www.enterprisesurveys.org/en/enterprisesurveys accessed on 18 December 2024).

The WBES focuses on many aspects of the business environment. These factors can be accommodating or constraining for firms and play an important role in whether an economy's private sector will thrive. The WBES uses stratified random sampling, with the following strata: firm size, most frequently small (5–19 workers), medium (20–99), and large (100+). Firms with less than five employees are ineligible for the survey. Firms that are 100% state-owned are also ineligible.

We analyzed the drivers of TFP at the firm level in Kazakhstan compared to the firm's investment in innovations, such as R&D expenditures and self-reported firm innovations, both product and process innovations that are new to the firm and its main market. To conduct the econometric modeling, we use available data from WBES (see https://microdata.worldbank.org/index.php/catalog/3735 accessed on 2 January 2025). The survey was conducted in Kazakhstan between January and October 2019. It was led as part of a collaboration among the European Bank for Reconstruction and Development (EBRD), the European Investment Bank (EIB), and the World Bank Group (WBG). The survey covered 1446 companies in Kazakhstan, of which 926 are in manufacturing and 520 are in services. We also used data from 2019 ES for the rest of the ECA region, covering 17,048 companies in this region (excluding Kazakhstan), 9433 manufacturing companies, and 7615 service companies (The World Bank Group, 2020).

3.3. Econometric Application

We build on the CDM model to study the relationship between user innovation and productivity (Bartelsman et al., 2016; Crépon et al., 1998; Lööf, 2005). It is a structural model that incorporates the investment decision in innovation, the innovation process, and the role of innovation in production. It accounts for (1) selectivity, (2) the fact that only a subset of firms actively participates in innovation activity, and (3) endogeneity, since some of the explanatory variables (namely indicators) in the model could be simultaneously determined as dependent variables. The main equation of the CDM model can be presented as follows:

$$Y = f\,(A, L, K, R) \tag{1}$$

where Y stands for output or productivity measure and A denotes TFP, which captures the efficiency with which inputs are used. L represents the labor input, usually measured based on the number of employees or total hours worked. K represents the use of physical capital, such as machinery, equipment, or infrastructure, and R represents investment in research and development, which is the focus of the CDM model.

The production function equation is a basic economic concept that represents the relationship between inputs (factors of production) and outputs (goods or services) in the manufacturing process. It describes how inputs are transformed into outputs, and the entire equation is referred to as follows:

$$Y = A\ (K\hat{}\alpha)\ (L\hat{}\beta)\ (R\hat{}\gamma)\ (\varepsilon\hat{}\delta) \quad (2)$$

where, in addition to Y, A, L, K, and R described above, we have included α-, β-, γ-, δ-elasticities representing the contributions of capital, labor, R&D, and other inputs to productivity, and ε the error term to capture unobserved factors and measurement error.

As for the econometric modeling, it explains firm performance, key innovation activities, and the level of innovation expenditure chosen. The first equation accounts for firms' innovation efforts (*INNOV**) and can be formally written as follows:

$$INNOVi^* = X'1ib + ui \quad (3)$$

where index i refers to firm i; X is a vector of regressors described below; and u is, under the assumption, the normally distributed error term. Since firms innovate only when the expected net profits from that activity are positive, the observation is a discrete event rather than a latent variable INNOV*. Therefore, the first equation models the probability that the firm innovates with a probit model:

$$Pr(INNOVi = 1) = \Pr(INNOVi^* > 0) = \Pr\left(ui > -X'1ib\right) \quad (4)$$

where $X'1$ is a vector of variables that affect the innovation investment decision and includes the following: the size of the firm, measured as log employment; a dummy variable for whether the firm belongs to a group; a dummy variable for whether the firm is an exporter; a variable that captures the importance of barriers to innovation due to the knowledge, cost, and market; and industry dummies. These variables are mainly those used in previous works (Casaburi et al., 2016; Crespi et al., 2014, 2016; Crespi & Zuniga, 2012). The approach to capture explanatory factors of propensity to innovate are like the ones to capture the impacts of innovation outputs on productivity, although different studies include different explanatory variables (Crespi et al., 2016; Crespi & Zuniga, 2012; Lööf et al., 2017; Rubalcaba & Deschryvere, 2022).

4. Results

In this section, we present the results of our country-level case study based on the GII and WBES data sources, which compares nine countries and uses data from Kazakhstan based on the perspective of firms. We present evidence on the country's innovation performance, focusing on innovation outputs and inputs based on linear regression and the proposed econometric model.

4.1. Descriptive Results Based on Innovation Inputs and Outputs (Based on GII Data and a Literature Review)

According to the present outcomes and the literature review, we consider that Kazakhstan needs to implement a policy of modernization and diversification to sustain economic growth, and innovation is a way to diversify its development (Dyussenov, 2019). Through diversification, the chances of responding to changes and discovering new opportunities help create competitive advantages by facilitating the development of better products, services, and technological achievements (Distanont & Khongmalai, 2020). Since independence, Kazakhstan has transformed and improved its economy, integrating the most advanced achievements in science and technology (Stavbunik & Pělucha, 2019). However, the economy is still overly dependent on commodities, and innovation development in Kazakhstan remains relatively low (Cornell University et al., 2020). The country has several characteristics that contribute to its innovation potential, including relatively high levels of education, the ability to generate, accept, and disseminate knowledge, high scientific productivity, and a constantly improving information and communication framework (Nabieva et al., 2021). Weaknesses in innovation potential include the weak link between R&D and production, the low share of high-tech industries, and the low rate of adaptation of the economy to domestic R&D, to name a few.

Regarding the current innovation situation in Kazakhstan, the low quality of innovations (Alibekova et al., 2020) and the failure of registered patents to produce more commercial products and services (Zhanbayev et al., 2020) have affected the country's competitiveness. In addition, the intensity of R&D and the level of sophistication of the knowledge created fall short of expectations. However, it is interesting to observe how the contribution and influence of small and medium enterprises on the country's economy affect the socioeconomic development of the region (Zhakupov et al., 2023). Looking at the GII, Kazakhstan is ranked 77th out of 131 economies analyzed in this index in 2020, with a slight downward trend since 2013.

Focusing on Kazakhstan's trends in innovation inputs and outputs, we realized that they are almost the opposite. Kazakhstan's overall GII score has been decreasing over the years—in equal proportion to its output score—experiencing a sharp drop, especially in 2015, because of the decline of oil prices in 2014–2015, decreased demand from local firms and importers, the devaluation of the Kazakh tenge, and budget reductions in state institutions (Achilov, 2016). Figure 2 shows the evolution of Kazakhstan GII inputs and outputs. Here, we can observe that, while inputs have maintained a constant upward trend until 2019 (ranging between 34 and 45 points), the innovation outputs score displays a downward trend between 26 and 15 points. On the Innovation Input sub-index, Kazakhstan ranked among the top three countries of Central and South Asia. However, globally, Kazakhstan ranked 60th on the Innovation Input sub-index in 2020, higher than in 2019 but lower than in 2018.

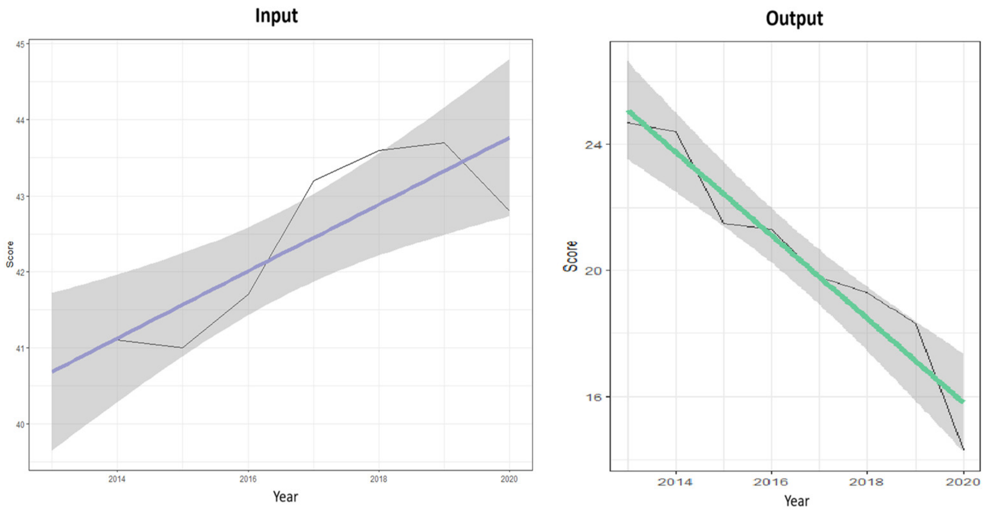

Figure 2. Imbalance between inputs and outputs in Kazakhstan (source: elaborated based on the GII (2020)). **Note:** The linear regression line has an equation of Y = a + bX, where X is the explanatory variable and Y is the dependent variable. If the slope of the line is positive, then there is a positive linear relationship. This figure also plots confidence intervals.

The overall assessment of the GII shows that Kazakhstan has remained relatively constant compared to the other economies analyzed, albeit with a slightly negative trend. However, Kazakhstan's innovation performance is lower compared to other economies.

The statistical confidence interval from 2013 to 2020 for Kazakhstan's ranking in the GII is between 74th and 80th. Although Kazakhstan has moved up 16 positions in the ranking compared to the first GII report in 2007, its position remains low relative to its income level. According to the World Bank's income classification, Kazakhstan ranks 24th out of 37 economies in the upper-middle income group covered by the 2020 GII.

Despite Kazakhstan's stable ranking in the GII and the improvement in individual components of the index, the development of the national support system and the introduction of innovations are at an early stage of development (Cornell University et al., 2020). Kazakhstan has begun to implement ambitious economic programs and is continuing the national innovation policy initiated in 2010–2014 (Bulasheva, 2017; Stavbunik & Pělucha, 2019). However, Kazakhstan's economy requires a high level of modernization and diversification. Kazakhstan's industry is highly dependent on natural resources, and the economy is dependent on exports of primary products, particularly hydrocarbons (i.e., oil, gas, and minerals) and agricultural commodities (Hutschenreiter et al., 2017; Kenzhaliyev et al., 2020; Mazhikeyev et al., 2015), which makes the country vulnerable to fluctuations in commodity demand and price volatility (Saiymova et al., 2018). This is another reason why business innovation in non-profitable sectors and ICT development are key to insulating the economy from external shocks related to commodity exports. Although every effort has been made to improve the ecosystem of science, technology, and innovation and its contribution to the diversification of the economy, success has been limited.

To compare the situation of Kazakhstan in innovation inputs/outputs with other countries in the region and other regional leaders, Figures 3 and 4 present the linear regression outcomes. Innovation inputs in Kazakhstan's performance between leading countries and neighboring countries during the period of 2013–2020 can be noticed as positive but less so than in most comparators. Figure 3 illustrates the GII input score, where Switzerland had an upward performance, followed by China, whose score rose drastically over the years analyzed, and India, whose score exhibits similar behavior. Innovation inputs in Russia and the other central Asian economies analyzed (except for Tajikistan) have experienced marked growth, most likely due to relatively strong economic growth, at least for some of the period, driven by their commodity exports. On the other hand, this could be due in part to assets inherited from the Soviet Union, in which most of the countries had a strong tradition in research, as well as highly trained human resources and institutions. Chile has had a moderate and sustained evolution over the years.

In particular, Kazakhstan has performed well in the Institutions, Human Capital and Research, and Infrastructure pillars. Kazakhstan has high scores in four out of the seven GII pillars, especially those that are related to the institutional input pillars, such as the Institutions, Human Capital and Research, and Infrastructure, on which it ranks above the upper-middle-income average. Kazakhstan (77th position) ranks third among the regional innovation leaders in Central and Southern Asia, but after India (48th position) and the Islamic Republic of Iran (67th position), according to the GII 2020 global ranking (Lööf, 2005). In addition, Kazakhstan has better results in the Market Sophistication pillar than in the Business Sophistication pillar. The Market Sophistication pillar is represented by three sub-pillars structured about business conditions and the level of transactions. The availability of credit and investment environment, including access to international trade, competition, and market scale, are all critical for businesses to prosper and for innovation to occur. The upper-middle-income group scores below the average for its income group, but Kazakhstan has improved this score in the last few years. Regarding the Business Sophistication pillar, this index captures the level of sophistication and assesses how conducive firms are to innovation exercise. This pillar is composed of three sub-pillars that measure the level of knowledge workers, innovation linkages, and knowledge absorption.

In this pillar, Kazakhstan is above the average of the upper-middle-income group (except Russia), although it is noticed that its score has decreased in line with the rest of the countries in this group. Some issues for this low performance in the Business Sophistication pillar have been identified, starting with factors for doing business in the country, where some signs of corruption have been detected, followed by difficult access to financing, inefficient government bureaucracy, and excess tax regulation (Schwab & Zahidi, 2020).

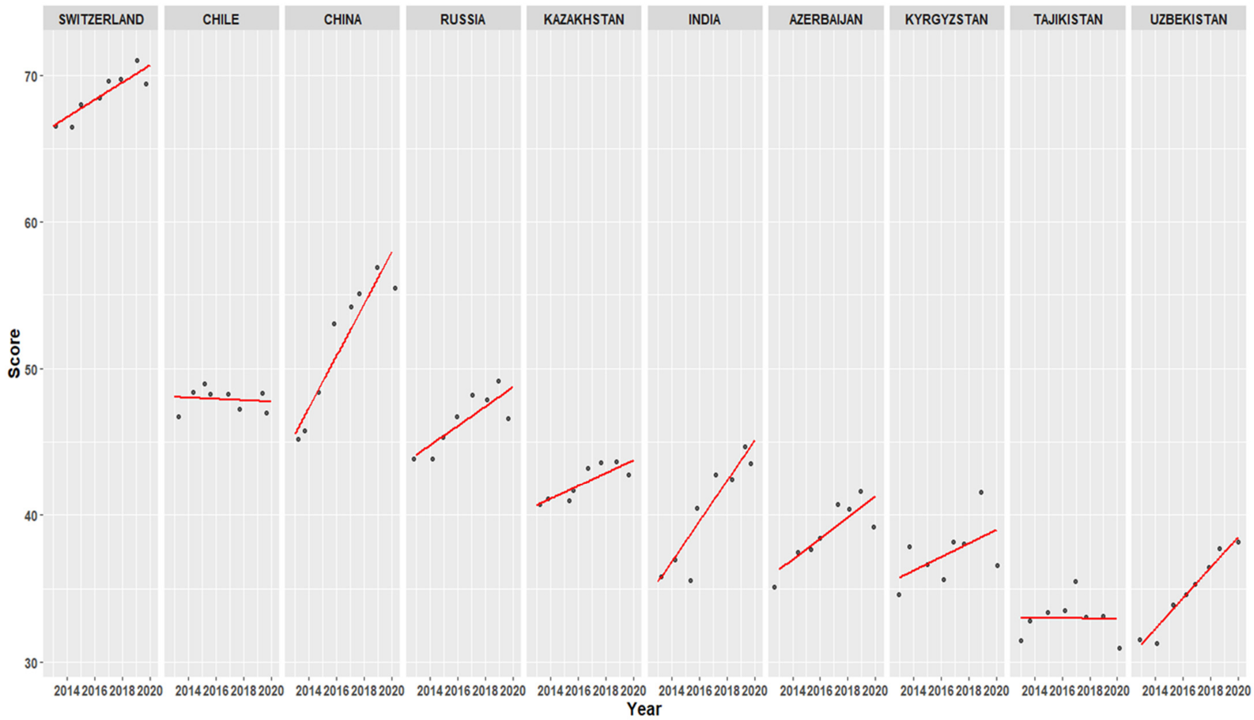

Figure 3. Innovation inputs of Central Asia and regional leaders (source: elaborated based on the GII (2020)). **Note:** The linear regression line has an equation of Y = a + bX, where X is the explanatory variable and Y is the dependent variable. If the slope of the line is positive, then there is a positive linear relationship.

In terms of innovation outputs, the trend in Kazakhstan's innovation outputs over the period 2013–2020 is downward, and the level of innovation output is below that of China and Russia and comparable to other Central Asian economies. As can be seen in Figure 4, with its solid output performance and increasingly diversified range of high-quality outputs, Switzerland remains the most innovative economy in the world, although its innovation outputs exhibit a declining trend. In the other economies analyzed, except for China, the trend has also been downward, with a marked dispersion of the scores in the cases of India and Tajikistan. This behavior could be due to the moderate technological level and the scarce promotion of innovative activities in economies with a strong tradition of being producers of raw materials and mineral and oil resources. The case of China is noteworthy. Decades of rapid economic growth have enabled China to invest in key areas that drive innovation, such as research and development and the creation of intellectual property outputs.

Through the implementation of the linear model, it can be noticed that Kazakhstan is one of the countries with lower performance in outputs compared to inputs. This country produces fewer innovation outputs relative to its level of innovation investments. The comparatively limited public support to technology businesses, particularly newly developing ones, limits the effectiveness of support measures targeting later stages in the development of companies. This, coupled with recent internal and external economic crises due to the nature of its economy, which relies heavily on the hydrocarbons sector, has contributed to the deterioration in the generation of innovation outputs (Saiymova et al., 2018; UNECE, 2012).

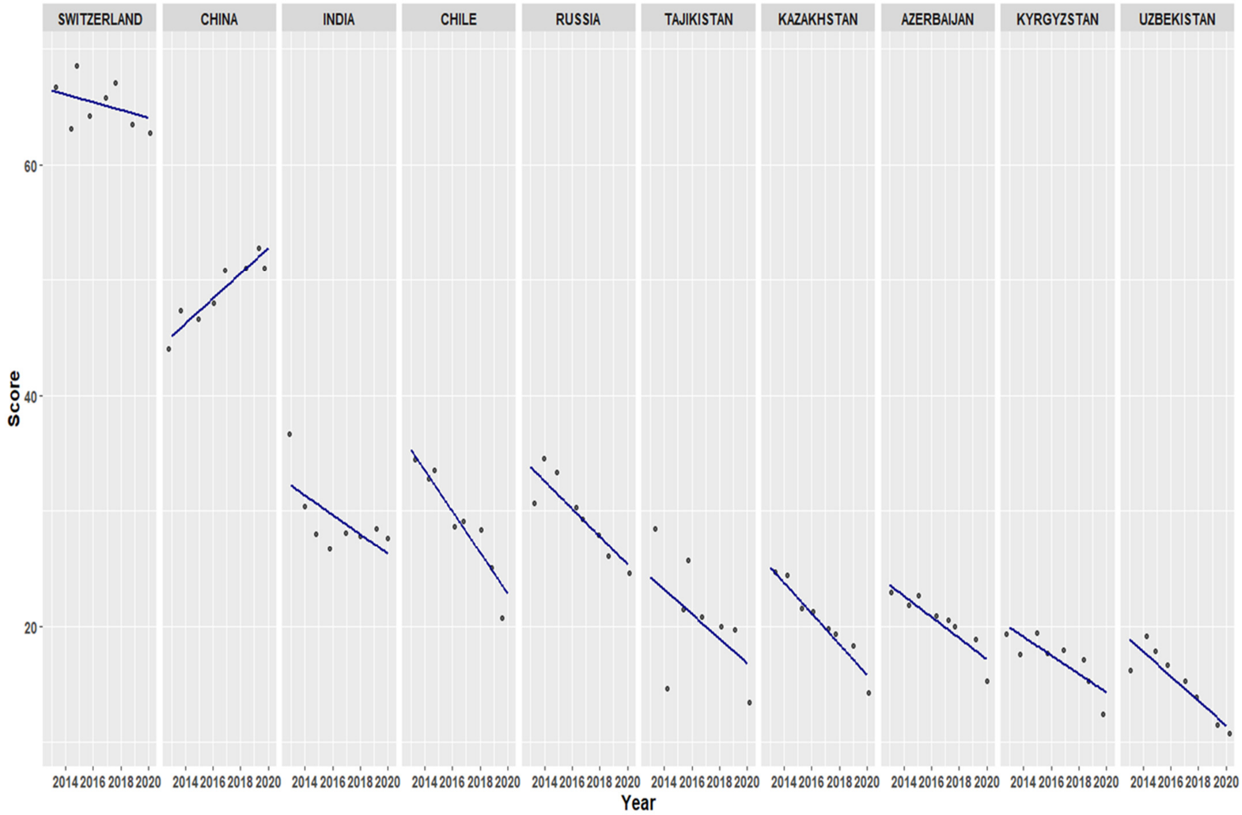

Figure 4. Innovation output of Central Asia and regional leaders (source: elaborated based on the GII (2020)). **Note:** The linear regression line has an equation of Y = a + bX, where X is the explanatory variable and Y is the dependent variable. If the slope of the line is positive, then there is a positive linear relationship.

4.2. Econometric Analysis (Based on WBES Data)

Starting with business performance indicators, such as real annual sales growth (%) and annual employment growth (%), Kazakhstan outperforms the economies of the ECA region and the upper-middle-income group. This is despite deficiencies in business innovation and the transformation of innovation inputs into outputs. Second, Kazakhstan performs poorly based on several innovation-related business metrics, such as investment in R&D, product or process innovation, and the use of foreign technology. For example, only 2.1% of Kazakhstani firms invest in R&D, compared to 10.2% of the ECA region firms and 13.5% of firms in middle-income countries. Similarly, only 18.7% of Kazakh firms reported product innovation, compared with an average of 32.3% and 35.7% of firms in the ECA region and upper-middle-income countries, respectively. There are also gaps in process innovation, the use of quality certificates, and the use of technology licensed abroad. These results from WBES are consistent with GII's earlier findings based on R&D and innovation. Third, the two selected trade indicators, such as the percentage of firms exporting directly (at least 10% of sales) and the percentage of firms exporting directly or indirectly (at least 10% of sales), have significant gaps compared to the ECA region average. This is important considering the role that competition in international markets plays in expanding businesses, improving efficiency, and increasing competitiveness (see Table 1).

Table 1. Key innovation and firm performance measures: Kazakhstan vs. ECA region and upper-middle-income averages, 2019 (source: World Bank staff elaboration based on World Bank Enterprise Surveys).

	Kazakhstan 2019				ECA Region Average, 2019	Upper-Middle Income Average, 2019
	All Firms	Small (1–19)	Medium (20–99)	Large (100 and Above)	All Firms	All Firms
Firm performance						
Real annual sales growth (%)	3.2	2.8	5.5	1.3	2.8	0.7
Annual employment growth (%)	7.4	7.8	6.6	3.2	3.0	4.5
Innovation and technology						
Percentage of firms that spend on R&D	2.1	1.5	3.2	8.8	10.2	13.5
Percentage of firms that introduced a new product or service	18.7	17.5	21.2	28.9	32.3	35.7
Percentage of firms whose new product or service is also new to the market	71.2	67.5	85.6	61.8	64.3	68.5
Percentage of firms that introduced a process innovation	10.2	7.5	18.4	21.4	18.5	29.3
Percentage of firms that use technology licensed from a foreign company	10.5	7.2	13.5	30.2	17.1	15.3
Percentage of firms with an internationally recognized quality certification	6.0	4.1	9.1	26.2	20.4	14.3
Trade and exporter status						
Percentage of firms that export directly at least 10% of annual sales	3.9	2.6	8.4	6.9	16.8	11.8
Percentage of firms that export directly or indirectly at least 10% of annual sales.	5.7	4.5	9.6	9.6	21.6	16.3

4.3. CDM Model Application

We use three-step methodology to examine the decision to invest in R&D, its impact on firms' technological innovation, and the impact of innovation on TFP. The first step of the analysis is to run simple probit regressions for the decision to invest in R&D (the investment decision) based on various firm characteristics. Second, we estimate the impact of investment in R&D on innovation performance as measured by firms' self-reported product or process innovations. Third, we estimate the impact of self-reported innovation on firm productivity (measured by TFP, using two different estimation models and using data from WBES for the ECA region but also including earlier periods). This mechanistic approach is not without problems, especially in terms of selection bias and endogeneity, since the decision to invest in R&D, firms' innovation outcomes, and productivity may influence each other in multiple ways and directions.

In this work, we consider the stages of a typical CDM model in isolation, purely for illustrative purposes and to try to identify possible differences between Kazakh and other ECA region firms in terms of influences on their investments in innovation. We then estimate the impact of innovation performance in Kazakhstan on the sales-based measure of TFP. Given the problems in estimating, the results should be treated with caution and are indicative of the strong correlation between the variables but not necessarily evidence of causality.

According to the WBES, the indicators are composed of many variables, which in turn originate from surveys carried out on companies. Indicators, such as age, size, and economic activity, to name a few, are provided by the managers of the surveyed firms. A full description of indicators and methodology is provided at https://www.enterprisesurveys.org/content/dam/enterprisesurveys/documents/methodology/ES_QuestionnaireManual_2019.pdf (accessed on 12 December 2024).

Data availability issues do not allow us to use the same variables for Kazakhstan and the ECA region (e.g., educational attainment and fixed asset borrowing), so some comparative conclusions must be understood as based on proxy comparative results.

4.4. Innovation and Firm Performance

Table 2 describes the results of the probit estimates for the observed binary decision of firm x to invest in R&D or not. We consider the entire set of Kazakh firms and compare them to the rest of the ECA region, and we split the sample into manufacturing and service firms. The results for Kazakhstan (columns 1–3) show that the probability of investing in R&D is significantly lower for small and medium-sized firms and, somewhat surprisingly, for firms with at least 10% foreign ownership. The exporter status is not associated with a higher likelihood of R&D investment, nor is access to finance, as represented by firms' use of credit to purchase fixed assets. On the other hand, the use of foreign technology in production and a well-educated workforce (captured by the dummy for firms that employ at least some college-educated workers) are positively and significantly associated with the decision to invest in R&D. Manufacturing firms are more likely to invest in R&D than service sector firms. Older firms are less likely to invest in R&D.

When we run the estimates separately for manufacturing and service firms (columns 2 and 3), some interesting results emerge. First, size does not seem to matter in the decision of manufacturing firms to invest in R&D, but it does in the service sector. Small- and medium-sized service firms are significantly less likely to invest in R&D. Access to finance is also a more important constraint for service firms, as the use of credit for fixed assets is positively associated with investment in R&D. Finally, Kazakh manufacturing exporters are significantly more likely to invest in innovation, but the results are not very conclusive.

When we compare the results for Kazakhstan with those of the same estimate for the rest of ECA region economies in 2019, several interesting findings emerge. First, exporting firms in the ECA region are much more likely to invest in R&D than their counterparts in Kazakhstan (columns 4–6 in Table 2). The exporter dummy is positive and highly significant in both the ECA region total estimate and the ECA region manufacturing estimate. This is a notable difference due to the profile of exporting Kazakh firms. Second, foreign ownership is much less significant for the decision to invest in R&D in other countries, with only foreign-owned manufacturing firms being negatively and significantly associated with a favorable decision. This may be due to the many multinationals that own subsidiaries in the ECA region and may invest in R&D at the headquarters level. Finally, as in Kazakhstan, the ECA region sample also shows a strong association between the education of the firm's workforce and the decision to invest in innovation. The dummy captures this for having at least some workers with at least a secondary education.

Table 2. Investment in R&D decision, probit model.

	Kazakhstan 2019			**Rest of the ECA Region 2019**		
	All Firms	**Manufacturing**	**Services**	**All Firms**	**Manufacturing**	**Services**
Indicators	P(RD) > 0	P(RD) > 0	P(RD) > 0	P(RD) > 0	P(RD) > 0	P(RD) > 0
Age	−0.190 *	−0.017 *	−0.020	−0.010	−0.006	−0.012
	(0.110)	(0.010)	(0.020)	(0.006)	(0.004)	(0.010)
D (Small)	−0.718 ***	−0.204	−1.129 ***	−0.712 ***	−0.665 ***	−0.695 ***
	(0.205)	(0.237)	(0.289)	(0.158)	(0.136)	(0.247)
D (Medium)	−0.466 **	−0.149	−0.554 *	−0.386 **	−0.233	−0.447 *
	(0.218)	(0.214)	(0.323)	(0.155)	(0.156)	(0.243)
D (Exporter)	−0.003	0.469 *	−0.312	0.005 ***	0.009 ***	0.002
	(0.218)	(0.265)	(0.385)	(0.001)	(0.002)	(0.002)
D (Foreign owned)	−1.563 ***	−1.391 ***		0.002	−0.004 ***	0.006 **
	(0.515)	(0.508)		(0.002)	(0.002)	(0.003)
D (University degree)	0.776 **	0.788 *				
	(0.381)	(0.420)				
D (Secondary education)				0.653 ***	0.581 *	0.695 **
				(0.242)	(0.348)	(0.299)
D (Borrowed fixed assets)	0.300	−0.216	0.639 **			
	(0.278)	(0.366)	(0.296)			
D (Foreign technology use)	0.974 ***	1.107 ***	0.803 **	0.590 ***	0.543 ***	0.642 ***
	(0.210)	(0.263)	(0.339)	(0.179)	(0.187)	(0.242)
D (Manufacturing)	1.074 ***			0.200 **		
	(0.158)			(0.101)		

Table 2. *Cont.*

	Kazakhstan 2019			Rest of the ECA Region 2019		
Constant	−2.614 *** (0.471)	−2.014 *** (0.468)	−1.571 *** (0.357)	−1.814 *** (0.305)	−1.758 *** (0.381)	−1.810 *** (0.412)
Observations	1385	871	489	15,295	8363	6932
Wald Chi2(9)	15 1.8 ***	33.54 ***	29.34 ***	87.61 ***	169.55 ***	34.77 ***
Pseudo R2	0.26	0.13	0.19	0.10	0.16	0.06

Robust standard errors are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Stratification weights are applied to correct for the economy sectoral structure in all specifications. Note: in the Kazakhstan specification for service firms only, the dummies for foreign ownership and university education are dropped due to predicting failure to invest in R&D perfectly. A full description of variables and methodology can be found at https://www.enterprisesurveys.org/content/dam/enterprisesurveys/documents/country-profiles/Kazakhstan-2019.pdf (accessed on 18 December 2024).

4.5. Innovation Investment in R&D

In this second stage, we perform a probit estimation for product and process innovations given a particular R&D investment decision. We control for various firm characteristics and run separate regressions only for Kazakhstan and the rest of the ECA region economies in 2019 (see Table 3). We also consider innovations that are new to a firm's market. The results are impressive, especially for the rest of the ECA region sample. The presence of investment in R&D increases the likelihood of both product and process innovations, including innovations that are new to the market, across the rest of the ECA region (columns 3–6 in Table 3). Among other firm characteristics, medium-sized firms are more likely to engage in process innovation and to use foreign technologies, and higher levels of workforce education are also associated with a higher likelihood of product and process innovation.

Table 3. Probability of technological innovation, probit model.

	Kazakhstan 2019			Rest of ECA Region 2019		
	Product Innovation	**Process Innovation**	**Innovation New to Market**	**Product Innovation**	**Process Innovation**	**Innovation New to Market**
Age	−0.001 (0.016)	−0.019 (0.017)	0.059 ** (0.027)	−0.004 (0.006)	0.004 (0.005)	−0.001 (0.011)
D (Small)	−0.654 ** (0.307)	−1.100 *** (0.276)	0.764 (0.667)	0.092 (0.160)	−0.148 (0.125)	−0.181 (0.257)
D (Medium)	−0.361 (0.360)	−0.333 (0.325)	−0.142 (0.669)	0.206 (0.171)	0.324 ** (0.143)	−0.518 ** (0.260)
D (Exporter)	0.332 (0.586)	−0.503 * (0.283)	1.051 * (0.598)	0.003 (0.002)	0.003 * (0.001)	−0.007 ** (0.002)
D (Foreign owned)	0.104 (0.341)	0.326 (0.388)	0.540 (0.585)	−0.0004 (0.002)	0.0001 (0.001)	0.002 (0.002)
RD	0.472 * (0.265)	0.459 * (0.258)	−0.780 ** (0.348)	0.710 *** (0.229)	0.370 ** (0.144)	0.619 *** (0.229)
D (University degree)	0.007 * (0.004)	0.005 (0.005)	0.005 (0.006)			
D (Secondary education)				0.897 *** (0.267)	0.643 ** (0.277)	−0.234 (0.697)
D (Informal competition)	0.227 (0.217)	0.696 ** (0.280)	−0.465 (0.364)	0.292 ** (0.129)	0.205 (0.135)	−0.136 (0.227)
D (Quality certification)	−0.266 (0.324)	−0.593 ** (0.258)	0.010 (0.424)	0.312 ** (0.143)	0.502 *** (0.161)	0.163 (0.244)
D (Foreign technology use)	0.376 (0.309)	0.345 (0.317)	0.741 (0.490)	0.631 *** (0.179)	0.623 *** (0.192)	0.289 (0.253)
D (Manufacturing)	0.175 (0.183)	0.029 (0.199)	0.414 (0.290)	0.199 * (0.104)	0.201 (0.125)	−0.078 (0.217)
Constant	−1.050 ** (0.451)	−0.934 ** (0.441)	−1.408 * (0.852)	−2.120 *** (0.327)	−2.455 *** (0.309)	0.717 (0.791)
Observations	1220	1215	301	14,089	14,037	4164
Wald Chi2(11)	19.70 **	33.86 ***	19.1 *	101.53 ***	119.58 ***	19.6 *
Pseudo R2	0.06	0.14	0.14	0.08	0.12	0.05

Robust standard errors are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Stratification weights are applied to correct for the economy sectoral structure in all specifications. Note: in the Kazakhstan specification for services firms only, the dummies for foreign ownership and university education are dropped due to predicting failure to invest in R&D perfectly. A full description of variables and methodology can be found at https://www.enterprisesurveys.org/content/dam/enterprisesurveys/documents/country-profiles/Kazakhstan-2019.pdf (accessed on 18 December 2024).

4.6. Innovation and Productivity

In this part of the analysis, we estimate the impact of firm innovation performance on firm productivity in Kazakhstan (see Table 4). Normally, this would be the third step in a CDM-type estimation model. Here, we take the product and process innovations self-reported by Kazakhstan firms and estimate their impact on TFP, which is estimated by the World Bank for all countries with available data. Specifically, we use estimates of TFP as of February 2021, called YKLM, which is derived from a Cobb–Douglass estimate of output on capital, labor, and materials, and VAKL, in which firms' value added is a function of capital and labor. These methodologies employ econometric techniques, like regression analysis, to isolate the contribution of inputs (capital, labor, materials) from residual output growth, which is attributed to TFP. Both measures are estimated under the assumption of a common production technology but also, whenever possible, separately for each industry, so that the elasticities of output to capital, labor, and materials may vary by country income group. More information on the methodology can be found at https://www.enterprisesurveys.org/ (accessed on 18 December 2024) and the World Bank Development Data Library: https://datacatalog.worldbank.org/ (accessed on 18 December 2024). In our study, we use both the Cobb–Douglas and value-added TFP estimations with sales as the output variable (based on WBES).

Table 4. Effects of innovation on TFP: OLS estimation for Kazakhstan 2019, manufacturing firms only.

	Kazakhstan 2019					
	TFP (YKLM)			**TFP (VAKL)**		
Observed product innovation	0.737 ** (0.367)			0.370 (0.270)		
Observed process innovation		0.433 * (0.238)			−0.064 (0.287)	
Observed product or process innovation new to the market			1.155 ** (0.520)			0.103 (0.411)
Age (years)	−0.017 (0.024)	−0.024 (0.025)	0.005 (0.032)	0.018 (0.026)	0.016 (0.026)	0.007 (0.026)
D (Small)	−0.357 (0.769)	−0.570 (0.751)	0.177 (0.798)	0.006 (0.397)	−0.207 (0.402)	0.706 (0.550)
D (Medium)	0.262 (0.750)	0.062 (0.733)	0.260 (0.797)	0.215 (0.379)	0.032 (0.386)	0.446 (0.567)
D (Foreign owned)	−0.019 (0.013)	−0.019 (0.014)	0.012 (0.008)	0.002 (0.005)	0.002 (0.005)	0.008 (0.007)
D (Exporter)	0.003 (0.005)	0.002 (0.005)	0.004 (0.008)	0.008 ** (0.004)	0.007 * (0.004)	0.017 (0.010)
D (Informal competition)	0.343 (0.355)	0.302 (0.350)	0.497 (0.381)	0.667 ** (0.300)	0.666 ** (0.307)	−0.283 (0.480)
Share of high-skilled workers	0.010 (0.008)	0.008 (0.008)	0.019 ** (0.007)	0.022 *** (0.006)	0.022 *** (0.006)	0.019 *** (0.005)
D (Quality certification)	1.361 ** (0.526)	1.417 ** (0.592)	1.757 *** (0.495)	0.284 (0.545)	0.315 (0.572)	1.335 ** (0.560)
D (Foreign technology use)	0.444 (0.510)	0.365 (0.495)	−0.820 * (0.446)	0.064 (0.281)	0.029 (0.274)	0.055 (0.311)
Number of observations	394	394	96	394	394	96
F statistic	244.39 ***	292.34 ***	54.02 ***	12.50 ***	12.95 ***	13.90 ***
R-squared	0.57	0.56	0.75	0.35	0.34	0.53

Note: robust standard errors are in parentheses. *** Denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level. Manufacturing sub-industry dummies are included in all regressions but not reported. Stratification weights are applied to correct for the economy sectoral structure in all specifications. Estimates of TFP are from World Bank Group, Enterprise Analysis Unit. 2017. "Firm-Level Productivity Estimates." A full description of variables and methodology can be found at: https://www.enterprisesurveys.org/content/dam/enterprisesurveys/documents/country-profiles/Kazakhstan-2019.pdf (accessed on 18 December 2024).

Among the firm characteristics, only an international quality certificate is positively and significantly associated with a higher TFP. The proportion of highly skilled workers in the firms appears to be significantly associated with a higher TFP in the VAKL model but not in the YKLM model. Innovations, either product or process innovations, that are also new to the firm's main market and not just to the firm are strongly associated with TFP, especially in the YKLM model where they are significant. However, the degrees of freedom in this estimation are much lower, so these results should be interpreted with caution. We also ran the same OLS estimates with the same indicators for the rest of the ECA region manufacturing data for 2019. We do not show these results here, but they suggest a lower importance of innovation for TFP.

5. Discussion, Conclusions, Final Remarks, and Policy Implications

This work aims to explain the imbalanced transmission from inputs into outputs and impacts in the context of research development and innovation in Kazakhstan. This discussion section has four subsections: compilation of key results, further discussion, caveats, and final remarks.

5.1. Summary of Key Results

The descriptive linear model based on the GII indicates an existing imbalance between many inputs and very few outputs of innovation. This is akin to the situation in other neighboring countries, but the imbalance case of Kazakhstan is of relevance and may be more related to deficiencies in the innovation ecosystem than to the overall economic development of the country.

On propensity to invest in R&D. The econometric results based on the CDM model suggest that larger Kazakh manufacturing firms are more likely to invest primarily in innovation, but exporting is not associated with such investments. This contrasts the rest of the ECA region, where exporting firms are more likely to invest in R&D. In addition, the quality of human capital, as expressed by the educational level of the firm's workforce, affects the decision to innovate, with firms with more educated workers more likely to invest in innovation. The use of foreign technology is also significantly related to the decision to invest in R&D.

On R&D and innovation. Investment in R&D is associated with a higher probability of product and process innovation, which is true for Kazakhstan and the rest of the ECA region.

On innovation impacts. Innovation performance affects firm productivity in Kazakhstan, at least for some TFP measures. The presence of international quality certification and a higher proportion of skilled labor also contributes to higher firm productivity. Interestingly, inherent firm characteristics, such as age, size, and foreign ownership, are insignificant in the various estimates of TFP in Kazakhstan and the rest of the ECA region.

Related to the hypotheses, our H1 (*R&D generates positive effects on outputs in Kazakhstan but less than in the ECA region because the inputs are less advanced*) is partly confirmed as R&D effects on innovation are positive: investment in this sector is also associated with a higher probability of product and process innovation Nevertheless, the results are weaker than those for the rest of the ECA region, where investment in R&D is significantly associated with the presence of firm-level innovation: something happens in the transmission from inputs into output. This is not necessarily related to the advanced condition of the country in terms of economic performance but in terms of other factors hampering the functioning of the eco-innovation system.

Our H2 (*Innovation outputs generate positive impacts on productivity in Kazakhstan*) is also partly confirmed as innovation effects on productivity are somewhat positive, but the reasons behind this deserve further research. Results show a strong positive relationship between observed product, process, and market innovations and TFP, but only for the YKLM estimation model. None of the innovation results are significant for the value-added estimates of TFP (VAKL model). Neither product nor process innovation is significant when controlling for the manufacturing sub-industry. This is interesting because it differs from the results in Kazakhstan. However, the ECA region regressions combine a wide range of firms and countries. Even the measures taken to correct bias and assumed elasticities between industries and countries are prone to some residual estimation error in TFP.

Regarding our final H3 (*Company size, education and skills, competition, exports, and the foreign ownership sector significantly influence the imbalance in converting innovation outputs into impacts in Kazakhstan*), the results are uneven depending on the factors. Results confirm the positive roles of factors, such as exports and education, in positive transmissions and uneven or insignificant results on productivity impacts from characteristics, such as the age, size, and foreign ownership. Large manufacturing firms in Kazakhstan tend to invest in R&D, but the fact that they export does not affect the investment decision. However, the quality of human capital in a company is associated with a higher probability of investing in R&D.

5.2. Further Discussion and Comments

The results are aligned with other evidence and suggest different implications. Despite the Government of Kazakhstan having established an effective innovation policy and making efforts to build innovation infrastructure, there is still a low level of innovation activity in the nation (Rubilar-Torrealba et al., 2022). For this reason, R&D spending as a percentage of GDP and the number of R&D employees need to be increased to boost the country's economic potential (Asian Development Bank, 2014). Although R&D in Kazakhstan is limited, it remains an important component of innovation spending. About 8% of R&D spending in the Kazakhstani economy is on basic research, with 40% on applied research and slightly more than half on experimental development. The composition of R&D in Kazakhstan's economy based on scientific fields is similar to that in developed countries, with engineering accounting for the largest share (about 75%), followed by natural sciences (16%). The share of agriculture (7%) is higher than the OECD average (but lower than in Chile, for example), reflecting the important role of agriculture and the food industry in Kazakhstan (Hutschenreiter et al., 2017). However, spending on medical research (1% of business R&D spending) is relatively low, showing the small role of innovative medicine in Kazakhstan's industry.

When endeavoring to comprehend the imbalance in the diffusion of innovation inputs and outputs in a specific country, we find ourselves constructing a suitable framework to establish indicators, such as the determining factors that can affect the findings of the econometric model. Diffusion of innovation refers to the appropriateness of individual technologies and ideas for specific situations at certain stages in development. Development studies explicitly broadened research on the spread of innovations to explore the political, technological, and ideological context of the innovation and any dissemination program and innovations' different meanings and social values in other societies (Greenhalgh et al., 2004). It is possible to explore the outcomes of our model and comprehend the interactions through the transmission of innovation using the GII and WBES data. However, the role of business innovation needs to be further explored using other significant sources.

As in Kazakhstan, the use of foreign technology by companies is positively and significantly associated with a favorable decision to invest in R&D, as is the fact that it is a manufacturing company rather than a service company. In addition, applying IT technologies to broad domains of traditional technologies has been the primary driver of convergence innovation, and the fusion of traditional and information technologies is advantageous to individuals and businesses (Lee, 2015). Still, the lack of innovation and low technological adoption are barriers to economic diversification (Dyussenov, 2019).

The national innovation system could be a key factor in the economic diversification process. Consequently, it is important to understand how innovation could improve the performance of strategic sectors to embark on the path to economic diversification. The country needs to promote collaboration among key stakeholders and provide incentives for collaboration between academia and business.

This is consistent with previous findings of gaps in the scope of R&D in Kazakhstan relative to comparator countries and could potentially mean that the quality of R&D is not high enough to generate innovation. In other words, these firm-level findings support the hypothesis derived from the GII that inputs, such as R&D, are not being transformed into outputs, such as new commercial products, services, or production processes. This underscores the proposition that Kazakhstan is inefficient in extracting maximum value from its R&D expenditures. Of the remaining explanatory variables (indicators), only the small size dummy is significant, suggesting that small firms are less likely to introduce product and process innovations. Therefore, business innovation must be strongly promoted to catch up with leading innovation countries. This requires learning more about the profile, composition, and quality of innovation carried out by firms.

As for the causes of the innovation gap, given the stage of innovation systems, considerable attention should be paid to the ability of Kazakhstani firms to absorb innovation and, in some cases, to the ability of firms to generate and share knowledge to increase business investment in R&D. One of the main causes of Kazakhstan's weak innovation performance and resulting stagnation (UNECE, 2012) is the limited role of firms in generating knowledge and the inherited structure of R&D, reflecting the legacy of the former planned economy during the Soviet era. In addition, given the importance of oil and gas in the national economy, this sector could be seen as a natural starting point for a diversification strategy in Kazakhstan. This industry can create linkages for local R&D and engineering players to produce capital goods needed by the industry. Domestic content requirements are forcing multinational companies to form such linkages with local firms. Such connections can be an important source of knowledge for local industry. The high-quality requirements of global companies can also provide incentives for domestic companies to improve their technology and quality. One example is the 2012 amendment to the Law on Subsoil and Subsoil Use, which requires subsoil users to invest 1% of their annual income in R&D, encouraging innovation and diversification of the economy. However, inadequate regulations, unclear eligibility rules, and poor implementation have hampered the effectiveness of this change.

Certain institutional factors have made technological and scientific infrastructure relatively available (Cornell University et al., 2020), highlighting strengths, particularly related to the innovation pillars: institutions, human capital and research, and infrastructure. Kazakhstan's public sector pays great attention to institutional development (Stavbunik & Pělucha, 2019), and the government plays a crucial role in the country's innovative development. However, the quality of infrastructure and R&D facilities is still somewhat anchored in the Soviet Union model (Mazhikeyev et al., 2015). In addition, regarding the importance of multinational companies investing in the formation of public–private funds at the local level (Goldberg et al., 2011) to finance new startups and strengthen the supply chain in extractive industries, such as oil, gas, and mining, the country is doing quite well in creating ICT infrastructure. Kazakhstan's education system faces challenges in training more qualified IT and other specialists for the ICT industry, as well as retaining highly qualified ICT specialists (Alibekova et al., 2020).

Undoubtedly, innovation is one of the levers available to managers to create a competitive advantage (Birchall et al., 2011), but there remains a large gap between what companies could get out of their investments in innovation. In the case of Kazakhstan, this country innovates mainly by absorbing new knowledge and technologies through importation, reverse engineering, and learning by doing (Samambayeva & Fernandez-Grela, 2013). This is supported, for example, by the finding that the contribution of the private sector to total R&D in Kazakhstan is higher than in countries, such as India and Chile, but it is lower than in Russia and China (see Figures 3 and 4). However, the innovation activity of Kazakh companies remains very low, especially among small- and medium-sized enterprises, and the entrepreneurial culture remains insufficiently developed. In this situation, SMEs are limited in their economic activity and operate mainly in conventional sectors (UNECE, 2012). The contribution of small innovative enterprises to the country's economy in 2015 was 5.9%, while in Russia it was 9.1% and in leading economies, it was around 50% (Temirgaliyeva et al., 2018).

5.3. Caveats

The current study and the econometric approach contain some caveats that may lead to further research on this topic. Firstly, the concept of innovation transmission is associated with a particular narrow version of the inputs/outputs relationship. Understanding imbalanced transmission would require an empirical study objectively describing the process of innovation diffusion in terms of the communication channels, time, and social and system theories. Secondly, the CDM models based on the micro-company self-reported is a well-established method for approaching innovation drivers and impacts but still contain some issues with endogeneity and selection biases that must be mentioned, but they do not avoid the publications of CDM articles in the last few years (Bartelsman et al., 2016; Castellacci, 2011; Cirera & Maloney, 2017; Crowley & McCann, 2018; Lööf et al., 2017; Rubalcaba & Deschryvere, 2022; Rubilar-Torrealba et al., 2022). Finally, the data limitations avoid more ambitious analyses covering more indicators and better linkages with final policy implications. More in-depth comparisons with other countries are also something pending for future research.

5.4. Final Remarks and Policy Implications

To sum up our study, the inquiry into why Kazakhstan has a surplus of innovation inputs but a relatively low output reveals a complex interaction of elements influencing the country's innovation landscape. The empirical evidence shows that translating these inputs into concrete innovation outputs and subsequent benefits is significant. The company size, education and skills, competition, exports, and the foreign ownership sector emerge as key drivers, with their combined influence significantly contributing to the observed imbalance. The findings reveal that while Kazakhstan has significant resources and initiatives to stimulate innovative inputs, there is a need for specific interventions to improve the efficiency with which these inputs are converted into practical outputs. The wealth of natural resources could be a starting point for a diversification strategy aimed at significant improvements in technology, infrastructure, and R&D, as well as training more skilled IT professionals in extractive and other industries.

The potential of the science and technology system needs to be tapped to facilitate the transformation of innovation inputs into outputs. In Kazakhstan, business R&D expenditures are low, although the share of business innovation in total innovation is relatively high. Technological innovation in the selected strategic sector would be crucial for Kazakhstan, as would digital transformation, which is taking place in all sectors of the economy. There is evidence of significant innovation potential due to massive breakthroughs in scientific and technological activity (Kenzhaliyev et al., 2020). The challenge, however, is to connect science with consumers. Expert advice, training, and knowledge-intensive business services are needed to be more productive and competitive and to make better and more efficient use of new technologies.

As a final policy implication, the promotion of business innovation may use different forms and instruments. Traditional instruments, such as R&D programs or tax deductions, to promote a powerful and high-quality R&D oriented to technological innovation are always needed. However, R&D is more effective and is integrated into the innovation ecosystem of the country. In this sense, collaborative R&D, technology clusters, and hubs play a key role in making the most out of the R&D. In addition, another important implication is the promotion of non-technological and service innovation that is complementary to technology. Organizational innovation, managerial capabilities, expert strategic advice, quality control and design, and other knowledge-intensive business services are all needed to maximize the outputs and impacts of innovation inputs. Policies on this kind of service are particularly relevant for developing economies (Rubalcaba, 2015). As Kazakhstan already has a good amount of investment in R&D, business services can be a key factor in unlocking the potential for business innovation.

Author Contributions: Conceptualization, L.R. and S.S.; methodology, S.S. and J.N.F.-R.; software, S.S. and J.N.F.-R.; validation, S.S. and J.N.F.-R.; investigation, L.R. and S.S.; resources, S.S.; data curation, J.N.F.-R.; writing—original draft preparation, S.S., L.R. and J.N.F.-R.; writing—review and editing, L.R., S.S. and J.N.F.-R.; visualization, J.N.F.-R.; supervision, L.R.; project administration, L.R.; funding acquisition, S.S. and L.R. All authors have read and agreed to the published version of the manuscript.

Funding: The authors thank the support obtained from the World Bank Group and the Ministerio de Ciencia, Innovación y Universidades of Spain.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data presented in this study are available upon request to the email j.franco.riquelme@upm.es. Access to the data is subject to the approval of the corresponding author of the article.

Acknowledgments: The authors acknowledge the World Bank Group and the Ministerio de Ciencia, Innovación y Universidades of Spain—Ayudas Margarita Salas, for the support received for the development of this research.

Conflicts of Interest: The authors declare no conflicts of interest.

References

Achilov, N. (2016). Evaluation of innovation policy in Kazakhstan in the period of globalization trends. *Business and Economics Journal*, *7*(4). [CrossRef]

Agbim, K. C. (2013). The relative contribution of management skills to entrepreneurial success: A survey of small and medium enterprises (SMEs) in the trade sector. *IOSR Journal of Business and Management (IOSR-JBM)*, *7*(1), 8–16. [CrossRef]

Alibekova, G., Medeni, T., Panzabekova, A., & Mussayeva, D. (2020). Digital transformation enablers and barriers in the economy of Kazakhstan. *The Journal of Asian Finance, Economics and Business*, *7*(7), 565–575. [CrossRef]

Asian Development Bank. (2014). *Innovative Asia: Advancing the knowledge-based economy—Highlights of the forthcoming ADB study report*. Asian Development Bank. Available online: https://www.adb.org/publications/innovative-asia-advancing-knowledge-based-economy (accessed on 18 December 2024).

Asian Development Bank. (2017). *Kazakhstan: Country partnership strategy (2017–2021)*. ADB. Available online: https://www.adb.org/documents/kazakhstan-country-partnership-strategy-2017-2021 (accessed on 18 December 2024).

Audretsch, D. B., & Belitski, M. (2020). The role of R&D and knowledge spillovers in innovation and productivity. *European Economic Review*, *123*, 103391. [CrossRef]

Bartelsman, E., Van Leeuwen, G., & Polder, M. (2016). Economics of innovation and new technology CDM using a cross-country micro moments database. *Economics of Innovation and New Technology*, *26*(1–2), 168–182. [CrossRef]

Birchall, D., Chanaron, J. J., Tovstiga, G., & Hillenbrand, C. (2011). Innovation performance measurement: Current practices, issues and management challenges. *International Journal of Technology Management*, *56*(1), 1–20. [CrossRef]

Bulasheva, A. A. (2017). Kazakhstan in Global Innovation Index 2017: A review and analysis of main characteristics. *Issyk-Kul Forum of Accountants and Auditors of Central Asian Countries*, *18*(3), 310–314.

Casaburi, G., Crespi, G., De León, I. L., Figal Garone, L., Grazzi, M., Guaipatín, C., Katz, J., Llisterri, J. J., Maffioli, A., Navarro, J. C., Olivari, J., Pietrobelli, C., Suaznabar, C., & Vargas, F. (2016). *La política de innovación en América Latina y el Caribe: Nuevos caminos* (J. Olivari, & J. C. Navarro, Eds.). BANCO INTERAMERICANO DE DESARROLLO. Available online: https://publications.iadb.org/es/publicacion/15612/la-politica-de-innovacion-en-america-latina-y-el-caribe-nuevos-caminos (accessed on 18 December 2024).

Castellacci, F. (2011). How does competition affect the relationship between innovation and productivity? Estimation of a CDM model for Norway. *Economics of Innovation and New Technology*, *20*(7), 637–658. [CrossRef]

Cirera, X., & Maloney, W. F. (2017). *The innovation paradox: Developing-country capabilities and the unrealized promise of technological catch-up*. World Bank. [CrossRef]

Cornell University, INSEAD & WIPO. (2020). *The global innovation index 2020: Who will finance innovation?* (S. Dutta, B. Lanvin, & S. Wunsch-Vincent, Eds.; 13th ed.) WIPO.

Crespi, G., Tacsir, E., & Vargas, F. (2014). *Innovation and productivity in services: Empirical evidence from Latin America*. (IDB Technical Note; 690). IDB. [CrossRef]

Crespi, G., Tacsir, E., & Vargas, F. (2016). Innovation dynamics and productivity: Evidence for Latin America. In M. Grazzi, & C. Pietrobelli (Eds.), *Firm innovation and productivity in Latin America and the caribbean: The engine of economic development* (pp. 37–71). Inter-American Development Bank, Palgrave Macmillan. [CrossRef]

Crespi, G., & Zuniga, P. (2012). Innovation and productivity: Evidence from six Latin American countries. *World Development*, *40*(2), 273–290. [CrossRef]

Crépon, B., Duguet, E., & Mairesse, J. (1998). Research, innovation and productivity: An econometric analysis at the firm level. *Economics of Innovation and New Technology*, *7*(2), 115–158. [CrossRef]

Crowley, F., & McCann, P. (2018). Firm innovation and productivity in Europe: Evidence from innovation-driven and transition-driven economies. *Applied Economics*, *50*(11), 1203–1221. [CrossRef]

Distanont, A., & Khongmalai, O. (2020). The role of innovation in creating a competitive advantage. *Kasetsart Journal of Social Sciences*, *41*(1), 15–21. [CrossRef]

Dyussenov, M. (2019). Who sets the agenda? Analyzing key actors and dynamics of economic diversification in Kazakhstan throughout 2011–2016. In H. M. Grimm (Ed.), *Public policy research in the global south: A cross-country perspective* (1st ed., pp. 119–149). Springer. [CrossRef]

Edeh, J. N., & Acedo, F. J. (2021). External supports, innovation efforts and productivity: Estimation of a CDM model for small firms in developing countries. *Technological Forecasting and Social Change*, *173*, 121189. [CrossRef]

Fedyunina, A., & Radosevic, S. (2022). The relationship between R&D, innovation and productivity in emerging economies: CDM model and alternatives. *Economic Systems*, *Elsevier*, *46*(3). [CrossRef]

Foreman-Peck, J., & Zhou, P. (2022). R&D subsidies and productivity in eastern European countries. *Economic Systems*, *46*(2), 100978. [CrossRef]

Galindo, M. Á., & Méndez-Picazo, M. T. (2013). Innovation, entrepreneurship and economic growth. *Management Decision*, *51*(3), 501–514. [CrossRef]

García-Pozo, A., Marchante-Mera, A. J., & Campos-Soria, J. A. (2018). Innovation, environment, and productivity in the Spanish service sector: An implementation of a CDM structural model. *Journal of Cleaner Production*, *171*, 1049–1057. [CrossRef]

Gault, F. (2018). Defining and measuring innovation in all sectors of the economy. *Research Policy*, *47*(3), 617–622. [CrossRef]

Goldberg, I., Goddard, J. G., Kuriakose, S., & Racine, J.-L. (2011). Igniting innovation: Rethinking the role of government in emerging Europe and Central Asia. In *Igniting innovation*. World Bank. [CrossRef]

Greenhalgh, T., Robert, G., Macfarlane, F., Bate, P., & Kyriakidou, O. (2004). Diffusion of Innovations in Service Organizations: Systematic Review and Recommendations. *The Milbank Quarterly*, *82*(4), 581–629. [CrossRef] [PubMed]

Griliches, Z. (1979a). Issues in assessing the contribution of research and development to productivity growth. *The Bell Journal of Economics*, *10*(1), 92. [CrossRef]

Griliches, Z. (1979b). Sibling models and data in economics: Beginnings of a survey. *Journal of Political Economy*, *87*(5 Part 2), S37–S64. [CrossRef]

Guru, B. K., & Yadav, I. S. (2021). Financial integration in Asia: A macroeconomic perspective. *Developing Economies*, *59*(1), 64–101. [CrossRef]

Hutschenreiter, G., Larrue, P., Horvat, M., Muraközy, B., Vaziakova, Y., & Anokhina, M. (2017). *OECD reviews of innovation policy: Kazakhstan 2017*. OECD. [CrossRef]

Ilmaliyev, Z. B., Patihan, T., Tursunbekov, D. M., Kenzhaliyev, O. B., Sansyzbayeva, D. B., & Kassymova, G. K. (2022). Motivating factors of innovative research activities and barriers to R&D in Kazakhstan. *Cakrawala Pendidikan: Jurnal Ilmiah Pendidikan*, *41*(3). [CrossRef]

Jardon, C. M., & Martinez-Cobas, X. (2022). Trust and opportunism in the competitiveness of small-scale timber businesses based on innovation and marketing capabilities. *Business Strategy & Development*, *5*(1), 69–79. [CrossRef]

Kenzhaliyev, O., Ilmaliyev, Z. B., Triyono, B., Minghat, A., Arpentieva, M., & Kassymova, G. (2020). Commercialization of research and development results as the economy growth factor of the republic of Kazakhstan. *International Journal of Advanced Science and Technology*, *29*(7s), 18–28.

Kesidou, E., & Szirmai, A. (2008). Local knowledge spillovers, innovation and export performance in developing countries: Empirical evidence from the Uruguay software cluster. *European Journal of Development Research*, *20*(2), 281–298. [CrossRef]

Lau, C. K. M., Yang, F. S., Zhang, Z., & Leung, V. K. K. (2015). Determinants of innovative activities: Evidence from Europe and Central Asia region. *The Singapore Economic Review*, *60*(1), 15500046. [CrossRef]

Lazonick, W., & Mazzucato, M. (2013). The risk-reward nexus in the innovation-inequality relationship: Who takes the risks? Who gets the rewards? *Industrial and Corporate Change*, *22*(4), 1093–1128. [CrossRef]

Lee, K. R. (2015). Toward a new paradigm of technological innovation: Convergence innovation. *Asian Journal of Technology Innovation*, *23*, 1–8. [CrossRef]

Leiponen, A. (2012). The benefits of R&D and breadth in innovation strategies: A comparison of Finnish service and manufacturing firms. *Industrial and Corporate Change*, *21*(5), 1255–1281. [CrossRef]

Lema, R., Rabellotti, R., & Gehl Sampath, P. (2018). Innovation trajectories in developing countries: Co-evolution of global value chains and innovation systems. *European Journal of Development Research*, *30*(3), 345–363. [CrossRef]

Leonidou, L. C., Katsikeas, C. S., Palihawadana, D., & Spyropoulou, S. (2007). An analytical review of the factors stimulating smaller firms to export: Implications for policy-makers. *International Marketing Review*, *24*(6), 735–770. [CrossRef]

Lööf, H. (2005). A comparative perspective on innovation and productivity in manufacturing and services. *Entrepreneurship, the New Economy and Public Policy: Schumpeterian Perspectives*, 181–202. [CrossRef]

Lööf, H., Mairesse, J., & Mohnen, P. (2017). CDM 20 years after. *Economics of Innovation and New Technology*, *26*(1–2), 1–5. [CrossRef]

Mahajan, V. (2010). Innovation diffusion. In J. N. Sheth, & N. K. Malhotra (Eds.), *Wiley international encyclopedia of marketing*. John Wiley & Sons, Ltd. [CrossRef]

Manatovna, T. A., Dabyltayeva, N. E., Ruziyeva, E. A., Sakhanova, G., & Yelubayeva, Z. M. (2023). Unlocking intersectoral integration in Kazakhstan's agro-industrial complex: Technological innovations, knowledge transfer, and value Chain governance as predictors. *Economies*, *11*(8), 211. [CrossRef]

Mansury, M. A., & Love, J. H. (2008). Innovation, productivity and growth in US business services: A firm-level analysis. *Technovation*, *28*(1–2), 52–62. [CrossRef]

Maradana, R. P., Pradhan, R. P., Dash, S., Gaurav, K., Jayakumar, M., & Chatterjee, D. (2017). Does innovation promote economic growth? Evidence from European countries. *Journal of Innovation and Entrepreneurship*, *6*(1). [CrossRef]

Mazhikeyev, A., Edwards, T. H., & Rizov, M. (2015). Openness and isolation: The trade performance of the former Soviet Central Asian countries. *International Business Review*, *24*(6), 935–947. [CrossRef]

Mukhtarova, K., Ziyadin, S., Kupeshova, S., & Doszhan, R. (2017). Problems of developing the foundations of sustainable competitiveness of industrial and innovative economy in Kazakhstan. *Economic Annals-XXI*, *168*(11–12), 38–43. [CrossRef]

Nabieva, M., Turmakhanbetova, S., Shamisheva, N., Khassenova, K., Baigabulova, K., & Rakayeva, A. (2021). Determinants of innovative development on the example of Kazakhstan. *Journal of Science and Technology Policy Management*, *12*(4), 651–665. [CrossRef]

Nenonen, S., Storbacka, K., & Windahl, C. (2019). Capabilities for market-shaping: Triggering and facilitating increased value creation. *Journal of the Academy of Marketing Science*, *47*(4), 617–639. [CrossRef]

Ramírez, S., Gallego, J., & Tamayo, M. (2019). Human capital, innovation and productivity in Colombian enterprises: A structural approach using instrumental variables. *Economics of Innovation and New Technology*, *29*(6), 625–642. [CrossRef]

Ravichandran, T., & Lertwongsatien, C. (2005). Effect of information systems resources and capabilities on firm performance: A resource-based perspective. *Journal of Management Information Systems*, *21*(4), 237–276. [CrossRef]

Rogers, E. M., Singhal, A., & Quinlan, M. M. (2014). Diffusion of innovations. In *An integrated approach to communication theory and research* (pp. 432–448). Routledge.

Rubalcaba, L. (2015). Service innovation in developing economies: Policy rationale and framework. *Emerging Markets Finance and Trade*, *51*(3), 540–557. [CrossRef]

Rubalcaba, L., & Deschryvere, M. (2022). The uneven role of users in service innovation performance. *Economics of Innovation and New Technology*, 1–24. [CrossRef]

Rubalcaba, L., Slavova, S., Kim, M. D., Merino De Lucas, F., Franco-Temple, E., & Victor, J. M. (2017). Innovation for productivity growth in ecuador: Unlocking constraints through horizontal and cluster development policies. In *Innovation for productivity growth in ecuador*. World Bank. [CrossRef]

Rubilar-Torrealba, R., Chahuán-Jiménez, K., & de la Fuente-Mella, H. (2022). Analysis of the growth in the number of patents granted and its effect over the level of growth of the countries: An econometric estimation of the mixed model approach. *Sustainability*, *14*(4), 2384. [CrossRef]

Saiymova, M., Yesbergen, R., Demeuova, G., Bolatova, B., Taskarina, B., Ibrasheva, A., Spankulova, L., & Saparaliyev, S. (2018). The knowledge-based economy and innovation policy in Kazakhstan: Looking at key practical problems. *Academy of Strategic Management Journal*, *17*(6), 1939–6104.

Samambayeva, A., & Fernandez-Grela, M. (2013). The internal innovation processes in Kazakhstan. In S. Sarı, A. H. Gencer, & İ. Sözen (Eds.), *International conference on eurasian economies* (pp. 227–237). Beykent University. [CrossRef]

Schwab, K., & Zahidi, S. (2020). *The global competitiveness report. How countries are performing on the road to recovery*. WEF. Available online: www.weforum.org (accessed on 18 December 2024).

Seber, G. A. F., & Lee, A. J. (2003). *Linear regression analysis*. Wiley. Available online: https://books.google.es/books?hl=es&lr=&id=X2Y6OkXl8ysC&oi=fnd&pg=PR5&dq=linear+regression+analysis+technique&ots=sfkTA3iRpq&sig=FLR1-NwRaNP3g_2XkYuSbxHd08A#v=onepage&q=linear%20regression%20analysis%20technique&f=false (accessed on 18 December 2024).

Sohn, S. Y., Kim, D. H., & Jeon, S. Y. (2015). Re-evaluation of global innovation index based on a structural equation model. *Technology Analysis & Strategic Management*, *28*(4), 492–505. [CrossRef]

Stavbunik, Y., & Pělucha, M. (2019). The innovation system of Kazakhstan in the context of the global innovation index. *The Innovation Journal: The Public Sector Innovation Journal*, *24*(1).

Su, X., Yan, X., & Tsai, C. L. (2012). Linear regression. *Wiley Interdisciplinary Reviews: Computational Statistics*, *4*(3), 275–294. [CrossRef]

Temirgaliyeva, A. S., Shadiyev, K. K., Demessinov, T. Z., Iskendirova, S. K., Orynbekova, G. A., Kopylova, O. V., & Valieva, M. M. (2018). Peculiarities of development of innovative enterprises in Kazakhstan. *European Research Studies Journal*, *XXI*(4), 331–342. Available online: https://www.um.edu.mt/library/oar/handle/123456789/36950. [CrossRef]

The World Bank Group. (2020). *ENTERPRISE SURVEYS. Kazakhstan 2019 country profile*. Word Bank. Available online: www.worldbank.org.

Uhlaner, L. M., van Stel, A., Duplat, V., & Zhou, H. (2013). Disentangling the effects of organizational capabilities, innovation and firm size on SME sales growth. *Small Business Economics*, *41*(3), 581–607. [CrossRef]

UNECE. (2012). *Innovation performance review of Kazakhstan*. Available online: https://unece.org/economic-cooperation-and-integration/publications/innovation-performance-review-kazakhstan (accessed on 18 December 2024).

Waheed, A. (2017). Innovation and firm-level productivity: Evidence from bangladesh. *The Developing Economies*, *55*(4), 290–314. [CrossRef]

Wejnert, B. (2003). Integrating models of diffusion of innovations: A conceptual framework. *Annual Review of Sociology*, *28*, 297–326. [CrossRef]

World Bank. (2010). *Innovation policy. A guide for developing countries*. The International Bank for Reconstruction and Development/The World Bank. [CrossRef]

World Bank. (2019). Kazakhstan reversing productivity stagnation: Country economic memorandum. In *Kazakhstan reversing productivity stagnation*. World Bank. [CrossRef]

World Bank Group. (2019). *Sustaining growth momentum: Kazakhstan economic update—December 2019*. WBG.

World Bank Group. (2020). *Economy profile of Kazakhstan. Doing business 2020 indicators*. WBG.

Ying, L., & Mengqing, S. (2011). Literature analysis of innovation diffusion. *Technology and Investment*, *2011*(03), 155–162. [CrossRef]

Yiu, D. W., Lau, C. M., & Bruton, G. D. (2007). International venturing by emerging economy firms: The effects of firm capabilities, home country networks, and corporate entrepreneurship. *Journal of International Business Studies*, *38*(4), 519–540. [CrossRef]

Younas, M. Z., & ul Husnain, M. I. (2022). Role of market structure in firm-level innovation: An extended CDM model for a developing economy. *Decision*, *49*(1), 91–104. [CrossRef]

Zhakupov, Y. K., Berzhanova, A. M., Mukhanova, G. K., Baimbetova, A. B., & Mamutova, K. K. (2023). The impact of entrepreneurship on the socio-economic development of regions. *Business Strategy & Development*, *6*(1), 13–19. [CrossRef]

Zhanbayev, R., Sagintayeva, S., Ainur, A., & Nazarov, A. (2020). The use of the foresight methods in developing an algorithm for conducting qualitative examination of the research activities results on the example of the Republic of Kazakhstan. *Mathematics*, *8*(11), 2024. [CrossRef]

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.