Do good institutions enhance the effect of technological spillovers on productivity? Comparative evidence from developed and transition economies

Version 1.8

Abstract

This paper argues that institutional quality has both direct and indirect (moderating) effects on productivity of countries. These hypotheses are tested using a battery of institutional proxies (governance, economic freedom, intellectual property rights and ease of doing business) and two channels for technological spillovers (trade and FDI) in a panel of developed and transition economies. The results confirm that good institutions have positive and comparable direct effects on productivity across the board. However, they moderate differently the relationship between foreign technological spillovers and productivity. Thus, governance, IPR and economic freedom exhibit negative moderation in the case of transition economies, while easiness of doing business moderates positively this relationship for both groups of countries. Further, the moderation effects are larger for transition economies and for trade-related spillovers. Overall, these results suggest a trade-off for transition countries between pursuing institutional upgrades and enjoying greater gains from technological spillovers.

Keywords: Institutions; productivity; R&D; technological spillovers; trade; foreign direct investment;

1 Introduction

Innovation and creation of new technologies are often regarded as the most important determinants of productivity improvements and economic growth (Grossman and Helpman, 1991; Romer, 1991; Hall and Jones, 1999). In this framework, technological spillovers from R&D performed abroad become significant source of growth, especially for developing and transition countries that are not able to perform significant R&D on their own. Starting with the seminal work of Coe and Helpman (1995), early studies have documented the impact of international trade on productivity of countries, while subsequent contributions have focused on refining methodological issues (Lichtenberg and Pottelsberghe de la Potterie, 1998; Lumenga-Neso et al., 2005), improving econometric techniques (Lee, 2006; Zhu and Jeon, 2007), exploring different channels for spillovers (Tang and Koveos, 2008; Le, 2012; Krammer, 2014), and examining these effects in the context of less-developed and emerging markets (Ciruelos and Wang, 2005; Krammer, 2010; Ang and Madsen, 2012).

While this stream of research provides valuable insights on the function of R&D spillovers in boosting productivity and growth, a parallel stream of literature postulates the pivotal role of institutions in determining cross-country and historical economic differentials (Barro, 1991; Rodrik et al., 2004; Bhattacharyya, 2009; Acemoglu et al., 2005). Overcoming numerous challenges regarding the conceptualization and operationalization of institutions, this interdisciplinary line of research has convincingly shown that "institutions matter" for a wide array of socio-economic activities within- and across-borders (North, 1994; Dixit, 2009; Ang, 2013). Institutional characteristics impact international trade flows by determining the amounts (Dollar and Kraay, 2003), channels (He et al., 2013) and types of goods (Meon and Sekkat, 2008) exchanged by countries. Likewise, institutional settings create both barriers and opportunities for FDI, as institutional differences between home and host countries of firms affect a multitude of microeconomic decisions, such as entry modes, staffing, and inter-firm alliances (Xu and Shenkar, 2002). As a result, institutional aspects are a strong predictor for the intensity and type of international activities in a country (Henisz and Swaminathan,

2008), which in turn determine its ability to benefit from foreign spillovers via trade and FDI.

With few exceptions, the direct and indirect effects of institutions on productivity have yet to receive significant attention in the literature. Overall, the few studies that have examined these issues find that countries with better institutions adopt faster technologies, and exhibit larger productivity growth (Manca, 2010). Economic growth appears intrinsically linked to institutions, which are able to both retard and encourage the utilization of new technologies that spur economic performance (Tebaldi and Elmslie, 2008). Therefore, countries that are less open to international flows of goods and finance due to greater institutional barriers, restrict the adoption of new technologies and tend to allocate a relative small share of human capital in the R&D sector (Dias and Tebaldi, 2012). In relation to R&D activities, Guellec and Van Pottelsberghe (2004) argue that besides absorptive capability and the origin of R&D funds, several institutional factors (the socio-economic objectives of government support, and the type of public institutions involved) determine the contribution of knowledge to productivity growth. Finally, institutional elements, legal origins and subsequent effects (i.e., education policies) appear to interact with productivity and trade spillovers in developed countries (Coe et al., 2009). All these results suggest important direct and indirect effects of institutions on both productivity and economic growth.

Despite these recent developments, the literature that links institutions to productivity and innovation-driven growth still lacks depth in several dimensions. First, the mechanisms through which institutional settings impact directly and indirectly productivity remain elusive, given the limited scope of research in this area. Trade spills over benefits from new technologies by opening up channels for communication and transmission of technical knowledge, reducing international duplication of R&D efforts, and providing additional incentives to innovate via increased competition from foreign products (Grossman and Helpman, 1991). Likewise, vertical linkages (i.e., customer or supplier relationships with MNEs), demonstration effects (i.e., imitation, adoption of foreign technologies or processes) and labor turnover

(worker migrating from MNE to domestic firms or new start-ups) are some of the most common mechanisms through which FDI spillovers affect productivity (Saggi, 2004). However, all these effects are contingent on the quality of institutions in the host countries, as the latter shapes both trade and market relationships between foreign and domestic firms, therefore impacting indirectly the scope of potential spillovers.

Secondly, the types of institutions examined may have different implications for certain channels of R&D spillovers and performance measures (i.e., growth rates, productivity levels, etc.). For example, Bhattacharyya (2009) suggests that market-creating (i.e., property rights, contract enforcement) and market-stabilizing (i.e., macro-economic stability policies) institutions appear to be growth-enhancing, while market-regulating (i.e., preventing market failures) and market-legitimizing ones (i.e., managing redistribution and social issues) have no economic impact. Relatedly, Dias and Tebaldi (2012) find that structural institutions affect long-term economic performance, while political institutions are not correlated with productivity and long-term growth. Moreover, the link between R&D (or technology) and institutional aspects remains largely unexplored, except for few qualitative studies that document their role in lowering transaction costs (Mokyr, 2008) and facilitating the expansion of growth-enhancing R&D projects (Romer, 2010). In parallel, the few empirical studies in this area suggest an intricate relationship between national institutions and innovation activities. On one hand, greater investments in education, strong property rights systems, easiness of doing business, complemented with measures to promote political and economic freedom, are positively correlated with technological performance (Varsakelis, 2006; Krammer, 2009). On the other, a tightening of property rights impedes the ability of followers to freely imitate foreign technologies, subsequently reducing their growth rates (Manca, 2010). Overall, these results suggest that the effects of institutions on R&D activities, and subsequently on economic performance, vary both across countries and institutional elements considered.

Thirdly, R&D spillovers offer the most significant growth opportunities for developing and emerging market economies, improving their odds of catching-up with developed peers (Fur-

man and Hayes, 2004). Thus, empirical findings in the literature document the importance of spillovers for less R&D intensive nations, such as developing (Ciruelos and Wang, 2005) and transition economies (Krammer, 2010). However, the type of institutional settings in place affects the successful conversion of these spillovers into productivity and growth improvements (Tebaldi and Elmslie, 2008). Therefore, given the existing institutional heterogeneity worldwide (Meyer et al., 2009), it is important to understand how different institutional features hinder or encourage the successful absorption of foreign technologies and ultimately contribute to productivity and economic growth across different types of countries.

Targeting some of these limitations, this paper examines the direct and indirect (i.e., moderating) effects of institutional quality on domestic productivity in developed and emerging markets. To this end, it analyzes foreign spillovers via two channels (i.e., inward FDI and imports) and employs several proxies for formal institutions (i.e., intellectual property rights protection, governance, ease of doing business, and economic freedom) in a panel of developed countries from Western Europe, and transition economies from Eastern Europe and Central Asia. The latter are particularly appealing to this line of research for several reasons. These countries have become the subject of a huge natural experiment in the early 1990s when they have embarked on a long and harsh path of transition from centralized closed economic systems to free markets. Alongside a painful restructuring process, which took a significant toll on their well-being, came also significant benefits from opening up to trade and foreign direct investments (Damijan et al. 2003). In parallel, institutional reforms were put in place and transition countries started to rebuild their systems, however with mixed results (Beck and Laeven, 2006). Despite significant signs of recovery and growth over the last decade, their performance in terms of trade, inward FDI, institutional reforms and productivity levels remains quite heterogeneous.

This work proposes several contributions to the existing literature. First, it develops theoretical arguments for the direct and indirect effects (via spillovers) of institutions on productivity and economic growth. This framework incorporates two channels for spillovers

of technological nature, namely FDI and trade flows, consistent with their increasing importance worldwide. Second, it adopts an empirical strategy that allows for heterogeneous effects of institutions on both productivity and R&D spillovers. Both the theoretical arguments developed in this study and prior empirical findings suggest potential assymmetric effects of institutional quality, contingent on the particularities of the countries examined. Finally, it provides a comparative analysis of these effects analyzing both developed and transition countries, which exhibit significant heterogeneity in terms of institutional quality (Meyer, 2009), innovative and productive performance (Krammer, 2009), and ability to benefit from foreign R&D spillovers (Krammer, 2010). These characteristics qualifies them as a propitious ground for testing these research hypotheses.

Next section provides an overview of the literature on international R&D spillovers and institutions, innovation and growth, developing theoretical arguments for the role of different institutions on productivity, and their interaction with R&D spillovers. Section 3 presents several stylized facts related to trade, FDI, and the institutional environment in transition countries, while Section 4 lays out the theoretical backbone for the empirical estimations, and summarizes the main features of the dataset employed. Section 5 describes the econometric methodology, issues, and the results of the analyses, while Section 6 presents conclusions and suggestions for future work.

2 Literature review and theoretical background

2.1 International R&D spillovers

R&D investments produce new knowledge about production inputs and processes, which contribute directly to quality and productivity enhancements. As a result, endogenous growth theory sees R&D as a significant source of economic growth, arguing that in order to achieve superior levels of productivity and income per capita, one needs to invest significantly in R&D (Romer, 1991; Hall and Jones, 1999). Despite this apparent consensus, it is clear that

the benefits of R&D activities cannot be fully internalized for several reasons pertaining to the intrinsic characteristics of knowledge (Griliches, 1979). The resulting externalities are defined as R&D spillovers that arise when economic benefits of one's R&D "spill" over to another's activities as a results of competitive pressures (*rent spillovers*) or imperfect appropriability of technical information (*knowledge spillovers*). In practice, distinguishing between the two is difficult, given their significant overlap and the inherent measurement problems. Thus, most studies adopt a general concept of spillovers for analysis and focus on the channels through which this phenomenon occurs as well as its subsequent contribution to productivity and growth (Krammer, 2014).

Within this stream of literature, trade has been postulated as an important channel for transmission of technological information (Coe and Helpman, 1995). Theoretical arguments suggest that trade, especially imports, facilitate the spill over of benefits from foreign R&D efforts through several mechanisms. First, through trade, domestic firms get acquainted with technical characteristics of imported goods, which opens up possibilities for imitation of foreign technologies for productivity and performance enhancements (Keller and Shiue, 2008). Second, international trade caters to a greater variety of intermediary inputs with different technological levels for the domestic production process, which in turn, increase technological content and value-added of products (Lee, 2006). Finally, trade opens up channels for communication and transmission of knowledge of technical nature, therefore stimulating international collaboration and reducing duplication of R&D efforts worldwide (Grossman and Helpman, 1991). Empirical findings confirm a positive effect of trade on productivity in both developing and developed nations (Lichtenberg and Pottelsberghe de la Potterie, 1998; Lee, 2006). Moreover, recent studies employing sector-level data reach a similar conclusion, namely that trade activities are one of the main avenues for spillovers (Acharya and Keller, 2007; Mancusi, 2008).

In addition to trade flows, foreign direct investment (FDI) has also been established as an important channel for spillovers driven by superior endowments of multinational enterprises

(MNEs) in terms of managerial, innovative and staffing capabilities. As a result, several theoretical mechanisms for FDI spillovers have been proposed in the literature (Saggi, 2004): vertical linkages (between firms and their customers, respectively their suppliers), demonstration effects (commonly taking the form of adoption or imitation of technologies developed by MNEs) and labor turnover (employees that leave MNEs for domestic firms or new start-ups, and take with them tacit knowledge regarding the business). All these spillovers yield significant horizontal and vertical effects on productivity of domestic firms in these markets (Saggi 2004). Moreover, consistent with the catching-up effect, these effects tend to be larger for developing countries, where differences in productivity between domestic firms and incoming multinationals is much higher than that of firms from industrialized countries (Krammer, 2010). In terms of empirical findings, most studies provide overwhelming support for the existence and the positive effect of FDI spillovers on domestic productivity. Despite the skepticism of early work in this area (Aitken and Harrison 1999; Djankov and Hoekman 2000), most of the recent studies document strong positive FDI spillovers from foreign R&D (Damijan et al. 2003; Haskel et al. 2007; Krammer, 2010). These effects are commonly examined for inward FDI flows, although few studies present also evidence of "learning by investing" (i.e., outward FDI) for developed nations (Van Pottelsberghe and Lichtenberg 2001).

2.2 Institutions, spillovers and productivity

Institutions have an essential role of supporting the proper functioning of a society by reducing the risks associated with market transactions. Commonly defined as human constraints of political, economic or social nature, institutions are responsible for shaping societal interactions (North 1990). As a result, institutional mechanisms are reflected in the political, social and economic context that affects the manner in which firms from different countries interact with each other. This line of thought has produced several streams of research across different disciplines that investigate the role of institutions in economic, social and political

international interactions.

Although scholars across these disciplines employ broad definitions of institutions, they hold different views regarding the operationalization of the concept. For example, following North (1990), economics researchers conceptualize institutions as having two components (informal and the formal ones) and tend to pay significant attention to the latter (Williamson, 2000). While informal institutions are derived from the cultural primers of countries and describe social interactions and patterns of behavior (i.e., trust, collaboration or subordination), formal institutions manifest themselves through rules and regulations that target mostly legal and economic issues (Peng, 2000). In contrast, those that adopt a more sociological perspective employ a framework that accommodates three institutional pillars, namely cognitive, normative and regulatory (Scott, 2001). In this view, informal institutional aspects are separated into normative and cognitive elements, which are tacit and deeply embedded in a normal functioning of a society. These are commonly perceived as the socio-cultural elements of a country. The third (regulatory) component includes formal institutional elements that are codified and promote certain behaviors among individuals and firms (Scott, 2001).

Researchers in international management have employed extensively institutional theory to explain different microeconomic (i.e., firm-specific) aspects (Peng, 2000). Institutional similarity or dissimilarity between home and host countries of multinational firms (MNEs) influences a wide array of firm decisions, including entry modes, staffing, alliance decisions, investment or export strategies (Xu and Shenkar, 2002; Hu et al., 2013). Thus, a general prescription of this stream of research is that greater institutional distance, or difference between home and host countries of MNEs, makes it less appealing and more difficult to operate in these environments.

Oppositely, the bulk of economic studies that focus on institutional issues targets a couple of key macro (i.e., country-specific) variables. Overall, these studies employ institutional arguments to explain historical growth performance and existing differences in per capita

income across countries. Barro (1991) suggests that growth rates are positively related to political stability and inversely related to market distortions. Rodrik et al. (2004) posit that institutional quality "trumps everything else" (i.e., geography, trade) in explaining differences in income per capita. Likewise, Acemoglu et al. (2005) make a strong case for the role of economic institutions in explaining differences in economic development. They also develop a framework that includes both economic and political institutions, which interact with each other in shaping economic outcomes, social decisions and distribution of resources. Finally, Ang (2013) shows that the historical effect of early stages of development on current economic performance works also through institutional upgrades.

Aside from their effects on economic growth and productivity, institutions have been also connected recently with innovation and R&D activities, both theoretically and empirically. Tebaldi and Elmslie (2008) propose an endogenous growth model which details the role of institutions in the economy. Their model predicts that the long-run growth of an economy is intrinsically linked to institutional quality, which in turn stimulates the efficient utilization of newly invented inputs and an optimal allocation of human capital in the R&D sector. Furthermore, Dias and Tebaldi (2012) take these arguments to the data and confirm that deep (historically rooted) institutional aspects of countries are responsible for long-term trends in productivity and growth. In relation to R&D activities and the role of spillovers, Guellec and Van Pottelsberghe (2004) argue that, besides absorptive capability and the origin of R&D funds, several institutional factors (the socio-economic objectives of government support, and the type of public institutions involved) determine the extent to which each source of knowledge contributes to productivity growth. Finally, in an extension of their 1995 seminal paper, Coe et al. (2009) test the effects of several institutional variables on a sample of developed countries. Their results generally suggest that OECD countries with stronger institutional environments are able to both perform more R&D and benefit more from foreign spillovers.

Despite these recent developments, the literature on productivity and technology-driven

growth has yet to fully incorporate the role of institutions in this framework, lacking depth in several dimensions. First, while the initial empirical inquiries into the interplay between institutions, technical knowledge from R&D, and subsequent productivity growth suggest a complex relationship (Guellec and Van Pottelsberghe, 2004; Coe et al., 2009; Dias and Tebaldi, 2012), this work remains silent in explaining the mechanisms through which institutions operate. Second, the complexity of institutional regimes, which may include very different types of institutions, requires a comprehensive examination of the interactions between productivity and institutions across multiple dimensions and channels of spillovers. Previous studies have shown that only some of them can be directly associated with growth (Bhattacharyya, 2009; Dias and Tebaldi, 2012), raising similar concerns regarding the indirect effect of institutions via spillovers. For example, as property rights regulations may affect the appeal of a country for foreign investors given the higher transaction costs and appropriation concerns, reducing the potential spillovers it receives via this channel, it may not be relevant for the effect of potential spillovers from imports. Thirdly, the relevance of institutions is conditioned by the inclusion of less developed and developing countries in these estimations. Most studies on R&D and productivity growth have difficulties in establishing a causal relationship between the two due to endogeneity issues. These concerns are further inflated upon introduction of institutions in these models and the lack of variation in the institutional quality by including only on developed (e.g., OECD) nations (Glaeser et al., 2004). Focusing on these limitations, next section proposes several theoretical arguments for the direct and indirect role of institutional quality on productivity.

2.3 Hypotheses

Institutional quality is closely associated with political and economic governance, as well as interactions among different societal members (North, 1990). As a result, institutions can directly promote or retard economic development through several mechanisms. First, having good institutions provides incentive for certain types of activities (i.e., those with

high private and social returns), while poor institutions encourage rent-seeking and non-productive activities with little benefits. Societies with low-quality institutional settings fail to achieve economic growth, as they are unable to capture productivity gains coming from the specialization and division of labor (North, 1990). Thus, a critical factor that may alter their development trajectories is the adoption of strong institutions that emphasize freedom (e.g., economic, political, religious etc.) alongside policies to develop human capital -e.g., targeting education, skill formation- (Lee and Kim, 2009). As a result, the development of democratic institutions is often regarded as a key driver of sustainable growth (Berg et al., 2012).

Second, institutional quality is associated directly with innovation, affecting both productivity and value-added of economic activities (Lundvall, 2007). An good example of these effects is the role of strong intellectual property rights (IPR). IPR is defined as formal institutional element which grants monopoly rights to inventors over the commercial use of their inventions within a limited time period (commonly around 20 years). Strong IPR legislation and enforcement triggers higher levels of domestic innovation, as firms are able to capture a greater share of the benefits stemming from internal R&D or innovations (Park, 2008). Moreover, for developing countries with lower IPR standards, strengthening these laws reduces appropriation concerns of multinationals regarding their proprietary technologies, resulting in greater international interactions, given the lower monitoring and protection costs of such activities (Roy and Oliver, 2009). Finally, IPR facilitates the transfer of technologies across countries by creating and supporting the existence of markets for technologies, in which firms are able to capitalize on their knowledge-intensive assets but also acquire new ones that will complement their existing competences (Arora et al., 2001). Hence, better IPR regulations facilitate different international interactions such as FDI (Branstatter et al., 2006), commercialization of foreign technologies (Gans et al., 2008), and firm collaborations (Oxley, 1999). Greater inflows of FDI as well as international collaborations raise the level of competition in domestic markets, which in turn stimulates firms to undertake more R&D or acquire tech-

nology from foreign sources in order to compete successfully in their home-markets. This ultimately results in productivity enhancements for domestic firms and host countries.

Besides the generic concept of institutions, specific institutional elements have also been associated with innovative and economic performance. Among them, governance (i.e., the institutional manifestation of authority within a country) includes an array of activities such as the government selection, monitoring and replacement processes, its capacity to formulate and implement effectively sound policies, the respect of citizens rights and social interactions among them and other entities of the state (Kaufmann et al., 2008). Good governance has been associated with higher investments (Mauro, 1995), growth rates (Posner, 1975) and innovative output (Mokyr, 1990). I argue that governance will affect positively productivity by strengthening the rule of law and the protection of property, cutting down transaction costs, providing alternative means to secure financial resources and increase the impact of the existing ones through lower governmental inefficiency and corruption. As a result, good governance promotes more efficient markets, which in turn increase productivity.

Economic freedom is another identification of a set of institutional characteristics that induces an efficient allocation of resources in a country and smoothens interactions between different economic agents, being firms, individuals and public officials. One should distinguish economic freedom from political and civil one, commonly encompassed in the concept of governance. Following the classical liberal thought these institutional characteristics focus on the stability and security of private property (but also freedom to save, change jobs, retain income, etc.), the size of the government (implicitly its power to intervene in the economy), access to sound money (i.e., low and predictable inflation), openness to trade and investments, as well as an optimal level of regulation in the economy for spurring entrepreneurial and innovative endeavors. Overall, studies report a positive relationship between economic freedom and growth rates (Gwartney, Holcombe and Lawson, 2004) as well as entrepreneurial activities (Nystrom, 2008). In relation to productivity, different institutionalized measures of economic freedom reduce transaction costs in the market, stimulate entrepreneurial ex-

perimentation and innovation, help allocate efficiently financial resources and open up new opportunities for domestic firms (Bjornskov and Foss, 2010). As a result, these mechanisms yield a greater variety of available inputs for the production process, which result in productivity increases.

Finally, the "ease of doing business" refers to the ability of the overall regulatory environment to stimulate business formation and development. A good level of business easiness implies less effort (time and costs) to operate a business, and countries seek improvements (i.e., new laws and regulations or revise existing ones) in this area to attract more foreign investors (Wei, 2000; Disdier and Mayer, 2004), stimulate domestic entrepreneurship (Audretsch and Thurik, 2001), and promote successful national innovation systems (Krammer, 2009). As a result, countries that adopt higher standards in terms of pro-business market reforms will benefit from more innovation from both domestic and foreign sources, which will translate into superior productivity levels as compared to lower institutional quality environments as a result of fewer pro-business reforms.

Overall, better formal institutions create a more favorable environment for new, innovative activities, which result in productivity enhancements and superior growth rates. Similarly, institutional quality attracts more inflows of FDI and trade into a country with positive consequences on productivity and growth. Given all these arguments, I hypothesize that:

Hypothesis 1: Institutional quality will have a positive impact on domestic productivity.

Although the direct effect of institutions on productivity and growth appears valid for all countries, its magnitude is likely to be contingent on the level of economic development (Meyer and Sinani, 2009). Hence, firms in countries with relatively lower institutional quality have greater incentives to improve their productivity via domestic (i.e., internal R&D) and foreign (i.e., acquire technology or collaborative R&D) sources, as a result of improvements in institutional settings. Oppositely, firms in countries with medium and high levels of institutional quality benefit already from a good environment, one that stimulates their domestic innovative capabilities and the amount of trade and FDI exposure they get. In

these cases, the effects of institutional quality on the contribution of spillovers to domestic productivity will be lower, as firms are already maximizing their productivity via technologies acquired through in-house R&D efforts or via external sources (e.g., licensing, international R&D alliances, etc.). Thus, it is likely that the direct effects of institutional quality on growth and productivity will be larger for countries with lower quality institutional environments than otherwise. Hence:

Hypothesis 2: The effect of institutional quality on productivity will be greater in less developed economies than in developed ones.

Besides their direct impact, institutions also affect indirectly the efficiency of R&D spillovers on productivity through several mechanisms. First, the amount of potential R&D spillovers is contingent on certain characteristics of the local environment. Among these characteristics, institutional traits are especially salient for both firm FDI and trade activities (Hu et al., 2013). As a result, institutional characteristics and specifically, institutional differences between home and host countries of firms operating internationally, remains a crucial determinant of what (e.g., exports, greenfield investments, joint-ventures, etc.) and where (location) firms operate internationally (Henisz and Swaminathan, 2008). Therefore, higher institutional quality (i.e., closer to the "standard" of a developed economy) will increase the efficiency of economic activities in a country as a result of institutional proximity (familiarity) of host and home countries of firms. In turn, this will lower transaction and coordination costs and enhance the effect of spillovers on domestic productivity.

Second, institutions affect also the type and composition of FDI and trade inflows a country experiences. For instance, manufactured exports are positively correlated with the quality of institutions, while non-manufactured exports are not (Meon and Sakkat, 2008). Similarly, institutions have a consistent influence on FDI in manufacturing and service sectors, while in the case of primary sectors (e.g., agriculture, oil, gas and mining) institutional quality appears not to affect inward FDI (Ali et al., 2010). Hence, countries that exhibit a production mix geared towards manufacturing and services are more likely to increase

their intake of traded goods and foreign investments, which in turn will affect positively the impact of spillovers on domestic productivity.

Third, institutional characteristics affect the depth and scope of the channels through which technological spillovers work. Similar to investments in R&D or skilled (trained) human capital, institutional progress stimulates both the exposure to and the chance of successful absorption of foreign technologies. Therefore, intuitively, they can be conceptualized as part of the absorptive capacity of a country. High quality institutions open up countries to receive more inflows of FDI and trade that carry significant technological content (Meon and Sekkat, 2008; Ali et al., 2010). These flows increase the domestic exposure to foreign technologies through a variety of mechanisms such as imports of intermediates, licensing agreements, demonstration effects, vertical linkages, and labor turnover (Saggi, 2004). Overall, open (trade and investment) regimes are more appealing to foreign firms and investors since domestic market size and characteristics are less of a constraint for inward FDI (Crespo and Fontoura, 2007). As a result, high quality institutional environments attract global players that produce and adopt the latest available technologies, therefore increasing the technological exposure (and spillovers) to host countries (Meyer and Sinani, 2009). Similarly, other institutional standards affect firms' capacity to absorb technologies, hence increase the effect of spillovers. In a recent study, Hale and Long (2011) argue that the rigidity of labor market regulations (wage constraints in particular) determine the absorptive capacity of firms by capping their level of skills, while (Alfaro et al., 2010) show that financial institutions are an important contributor to the successful absorption of spillovers.

These moderating effects of institutions on the relationship between technological spillovers and productivity can be detailed across different institutional proxies. First, countries that are able to improve their governance systems (e.g., rule of law, bureaucratic inefficiency, government effectiveness) are likely to receive larger inflows of FDI and domestic investments (Gani, 2007). Moreover, the composition of these inflows is different from that of a low-governance country, incorporating more technology-intensive assets and investments as

compared to the latter (Smarzynska-Javorcik, 2004). In turn, this increases the effect of technological spillovers on domestic productivity. Second, institutional regimes with high economic freedom are appealing for both foreign investors and domestic entrepreneurs alike by granting lower levels of regulations, security of property rights, and enhanced flexibility in these markets (Gwartney et al., 2004). This attracts high-technology MNEs and stimulates smart-growth strategies as a result of domestic entrepreneurial developments (Foray et al., 2009), both of which reinforce the positive effects of spillovers on productivity. Thirdly, stronger IPR regimes will provide more incentives for foreign firms to pursue technology-intensive projects in host countries, increasing technological spillovers from trade and FDI activities (Coe et al., 2009). Moreover, they also stimulate innovation and investment in technologies by domestic firms, as stronger IPR will make more likely that these investments will pay off in terms of competitive advantage in the markets (Gans et al., 2008). Finally, pro-business market reforms (or the easiness of doing business aspects of institutions) impact positively the relationship between technological spillovers and productivity of countries by strengthening their national systems of innovation and encouraging the absorption and diffusion of new technical knowledge (Barbossa and Faria, 2011). These institutional reforms targeting business formation and operation are different from targeted innovation policy measures, and contribute indirectly to technical-driven productivity enhancements via a stronger national system of innovation as a result of more foreign investors and venture capitalists, technological partnerships with MNEs, entrepreneurial incentives for universities and individuals (Allard et al., 2012).

To sum up, I posit that countries with higher institutional standards will likely strengthen their national innovation systems, provide stronger incentives for innovation-driven productivity growth, attract larger inflows of FDI and trade, and boost their capacity to convert technological spillovers into productivity gains. Hence:

Hypothesis 3a: The effect of R&D spillovers on productivity is positively moderated by institutional quality.

However, institutional quality can also reduce the effect of technological spillovers on productivity for several reasons. First, countries with large domestic markets and significant resources are still able to attract significant FDI and trade inflows (and subsequently spillovers) despite having low quality institutions. For instance, the former Soviet economies are among the top destinations for both FDI and trade flows due to their significant resource endowments and infrastructure (Kinoshita and Campos, 2003). More generally, Asiedu and Lien (2011) show that the importance of institutions in promoting FDI depends on the value of minerals and oil in a country's export basket. Hence, countries with low-quality institutions but significant resource endowments are still attractive investments, given the exclusivity of exploitation and splitting of profits to a small exclusive elite group (e.g., oligarchs). In these cases, good institutions, regardless of their nature (governance, property rights, etc.) chips away from these rents and may actually deter the appeal of investments and trade activities with these partners. Furthermore, strengthening existing IPR regimes may actually reduce domestic productivity by promoting an "intellectual monopoly" that is detrimental for innovation in less developed countries (Boldrin and Levine, 2008), and biased towards high-tech industries (i.e., pharmaceutical, biotechnology, electronics) that are not representative for the industrial mix of these countries (Hall, 2007). As a result, institutional quality may have antagonistic effects on the relationship between technological spillovers and domestic productivity.

Second, lower institutional standards confer governments more leverage in dealing with MNEs and increasing the potential for spillovers via targeted policy measures. Thus, in countries with less stringent institutions, governments can set up agreements with foreign firms through which domestic firms access foreign sources of technologies freely or at a low cost. A good example of this is the "quid pro quo" policy of China, which requires foreign firms to transfer technology to Chinese firms in return for market access (Holmes et al., 2013). While this results in significant technological gains for Chinese firms that translate directly into productivity improvements and higher rates of innovation, it has also leads to

lower flows of FDI between China and developed countries with significant technological assets. Any institutional improvements (e.g., governance, IPR, business reforms or freedom, etc.) would alter this balance of power between host country government and the MNE in the favor of the latter, resulting in less control and free technological benefits for domestic firms and individuals. Likewise,another mechanism through which governments can affect the magnitude and of technological spillovers are the institutional regulations and treatment of foreign firms. For example, Du et al. (2011) show that foreign firms that receive investment subsidies generate positive spillovers, whereas those that do not receive these subsidies generate negative spillovers. The effects of these spillovers is further enhanced if the foreign firm is enjoying tax exemptions. All this evidence suggests that lower institutional standards can be successfully harnessed by governments in less developed countries in order to maximize potential technological spillovers from international interactions throughout the economy. Oppositely, adhering to higher institutional standards will prevent governments from undertaking such actions, therefore reducing the scope for potential spillovers.

Finally, institutional quality reduces the scope of trade and FDI spillovers by affecting the channels through which these occur. With low institutional quality, domestic firms can often imitate foreign technologies to improve their productivity at no cost. Improvements in formal institutions (i.e., better regulations, stronger IPR protection and applicability of the law - governance-) diminish significantly firms' opportunities to access technical knowledge and benefit from demonstration effects, as these are shielded against unlawful imitation through patent and copyright laws that are properly enforced. Chen and Puttitanun (2005) conclude that developing countries benefit from lower IPR standards as they are in an early stage of technological development. Therefore, countries with no significant R&D activities benefit more from having low-quality institutional settings than otherwise, as they are able to internalize more benefits from foreign technology sources. Moreover, higher institutional standards in other areas (e.g., labor, competition, or environmental issues) reduces significantly the appeal of developing nations as a destination for FDI, as one of its major

drivers is the cost saving strategy (Dunning and Lundan, 2008). An economy with greater trade and FDI openness might attract outward-oriented foreign firms that are interested in international distribution and marketing, rather than inward-oriented firms that bring new technologies to host countries (Crespo and Fontoura, 2007). As a result, many MNEs will use developing countries as an export platform rather than a development one, which will constrict the amount of spillovers they receive. Lastly, increased institutional standards in the financial domain may have negative effects on domestic firms' access to funds impeding their development and capacity to benefit from foreign spillovers. Hence, better financial institutions may actually increase competition for financial resources in these markets, further deterring domestic firms from investing in R&D and skill upgrading as a way to improve their capacity to benefit from spillovers (Agarwal et al., 2011)

Overall, better institutional quality implies less room for imitation of foreign technologies, lower bargaining power in interactions with foreign firms, and negative effects from competition and access to finance vis-a-vis multinational firms, all of which reduce the potential of foreign technological spillovers. Therefore, I have the competing hypothesis:

Hypothesis 3b: The effect of R&D spillovers on productivity is negatively moderated by institutional quality.

Local firms with exposure to imported goods and foreign partners (via FDI, M&As, JVs, etc.) are able to learn from them via several mechanisms such as vertical links, demonstration effects and labor turnover (Coe and Helpman, 1995; Saggi, 2004). However, the extent of these learning effects depends on the local catch-up potential, commonly referred to as absorptive capacity: those firms and countries which are relatively backward (far from the technological frontier of the world-i.e., the state of the art in terms of innovation and new technologies) will have the greatest potential for productivity improvements by imitating or copying productivity-enhancing products, processes or practices. Oppositely, firms and countries that are closer to this frontier would gain much less from such imitation, given their relative advanced position, which would require more R&D efforts to advance significantly

their current productivity levels. Thus, the potential for foreign technological spillovers is enhanced by the existence of greater technology-gaps (Ciruelos and Wang, 2005) that are characteristic to developing and transition economies. Moreover, contingent on existing absorptive capabilities in the form of human capital and knowledge stocks (Krammer, 2010), these technological laggards can benefit significantly in terms of productivity improvements.

Despite its strong theoretical arguments, the above technology-gap hypothesis is still not widely embraced in the literature, given its underlying assumptions (Meyer and Sinani, 2009). One such assumption is concerned with the nature of the knowledge, commonly perceived as a quasi public good, which is difficult to prevent from diffusing and protect against unlawful imitation or reverse-engineering by domestic firms. Such conditions apply to certain standardized technologies and management practices, but however, not to the core-competences and technological assets of foreign MNEs. Similarly, the degree of technological embeddedness of imported products and intermediate goods presents finite options for imitation and reverse engineering. All these arguments suggest that spillovers are likely to occur under specific conditions. These conditions are best met in less developed economies that exhibit looser institutional environments and greater technological gaps vis-a-vis trade and investment partners. Therefore I posit that:

Hypothesis 4: The moderation effect of institutional quality is greater in less developed economies than in developed ones.

3 Stylized facts about trade, FDI and institutional quality in transition economies

While most studies on foreign R&D spillovers and productivity are centered around OECD (developed) nations, the catching-up hypothesis (i.e., developing nations that are further behind in terms of income for capita are more likely to benefit from these spillovers and grow faster, conditional on their absorptive capacity) and existing institutional heterogeneity

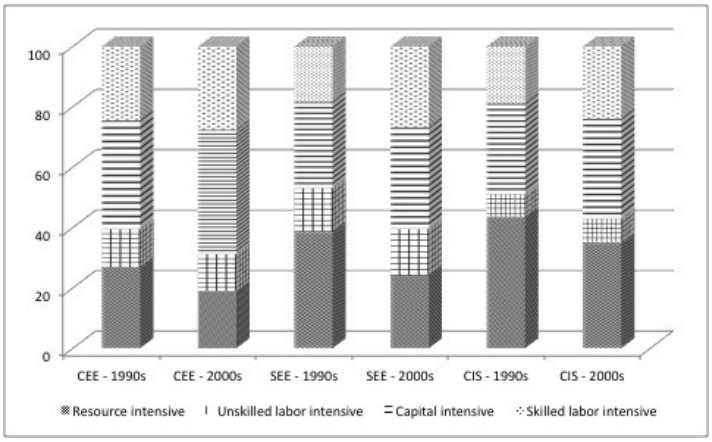

Figure 1: Factor use for imports of transition countries
Source: own calculations using data from IMF DOTS. Note: CEE-Central and Eastern Europe; SEE-South Eastern Europe; CIS-Commonwealth of Indepedent States

suggest that these research questions are especially salient for less developed nations. Among them, transition countries from Central Asia and Eastern Europe are particularly interesting for several reasons. Most of these countries have made significant improvements over the past 20 years in aligning their social, political and economic institutions to the rest of the world, a process known as the transition period. However, they still exhibit large differences both compared to the average institutional quality of an OECD country and within their peer-group, due to economic, social and geographic factors. As a result of the reforms undertaken, a surge of trade and FDI flows has become visible also in this part of the world. The following paragraphs will describe the nature and scope of these international flows in parallel with improvements signaled in terms of institutional settings from 1990 to the present.

Over the past decades, trade has grown faster in transition countries than elsewhere in the world, in a rush to fill the void created by the decades of communist isolationism. Thus, the exports of transition countries tripled and their imports increased two and a half times. However, the fine details are less optimistic since most of these developments are driven by Central and East European (CEE) success stories. Meanwhile, trade in the Commonwealth of Independent States (CIS) is taking place mostly through the regional partnerships and remains heavily polarized around the Russian Federation (Broadman, 2005). As a result, with the exception of Russia and Ukraine, all other CIS countries have not become more globally

integrated over the last 20 years. Overall, there is a clear trend towards increased regionalism, and all transition countries (CIS, SEE and CEE) are trading more among themselves in 2000s compared to the 1990s. Moreover, there is a clear polarization of trade relations for these countries. For the SEEs and CEEs this implies more imports from the European Union (EU-15), while for CISs the concentration remains geared towards Russia. Finally, consistent with the Heckscher-Ohlin theory, capital and high skilled intensive products dominate imports, and their shares have increased substantially in all transition countries (see Figure 1) suggesting greater potential for spillovers on domestic productivity.

In parallel, FDI inflows have followed a similar path. Increasingly, Eastern European countries have become quite successful in attracting foreign direct investment, as reflected by their larger inward FDI flows and stocks (see Figure 2). Until recently, the most popular targets were Central European countries, namely Czech Republic, Hungary and Poland. However, in the last years this trend is slowly changing. For example, according to UNCTAD (2007) in 2006 the inflows grew by 68 % to $69 billion, and the most targeted countries were resource-intensive (Russian Federation, Kazakhstan, Ukraine) and new EU members (Romania and Bulgaria). This trend has continued in the post-crisis period. Overall, FDI inflows have a stable share of 5% of the GDP, while the FDI stocks in absolute numbers have grown significantly. In terms of sectoral composition of foreign investments, manufacturing (35% of the total), financial intermediation (22%) followed by transport and communication (12%) and wholesale and retail activities (11%) are prominent in Central and South Eastern Europe. The top investors in the region are West European countries like Germany, Netherlands or Austria, seconded by the USA. Outward flows from the region have also surged in the last years, mostly due to the expansion of Russian multinationals seeking key investments abroad.

In terms of institutions, these countries have made significant progress through a long series of reforms. However, despite their impressive progress in the post-Soviet period, the average development level of institutions in the region is weaker than that of other countries

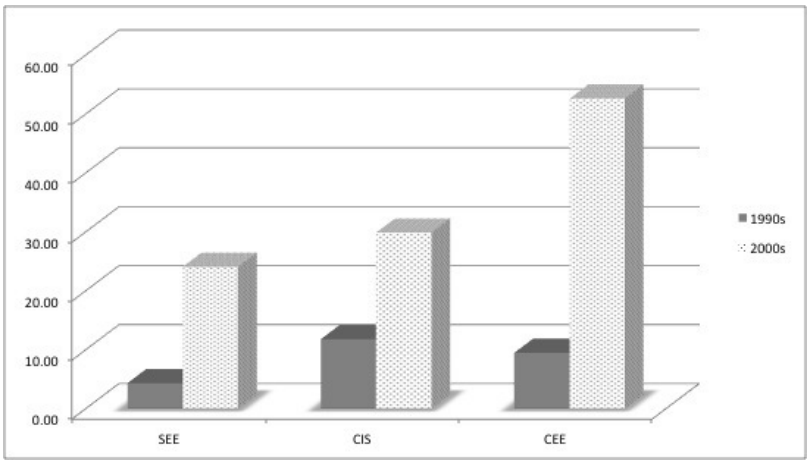

Figure 2: FDI intensity in transition countries
Source: own calculations using data from World Development Indicators. Note: The indicator is computed as the average inward FDI stock as a percentage of GDP across time and countries

with similar income levels. Even within transition economies the differences between Central European, South Eastern European and the CIS countries remain blatant (Figure 3) and of similar magnitude across different institutional elements. These suggest significant structural differences across transition countries in terms of institutional efficiency and how they operate. While scholars argue that institutional quality is determined by democracy and political reforms, other exogenous factors (e.g., history, geography, resource endowments, proximity to the EU) are known to trigger institutional change. Although these factors are fixed or difficult to change, their effect can be counteracted or complemented through policy measures to support international integration, political reform and increased political transparency (EBRD, 2013).

The recent economic and financial crisis has impacted severely the growth perspectives of transition economies. Moreover, the effects of the crisis were transmitted through trade and the financial channels (Gardo and Martin, 2010) that ultimately affected also their gains from spillovers via these channels. First, capital inflows dropped drastically, crippling significantly the domestic growth perspectives. As a result, most of these economies experienced significant disruptions, beyond that of other emerging markets such as India or China (Fidrmuc and Mayer, 2010). Second, this financial tightening has resulted in a contraction of trade

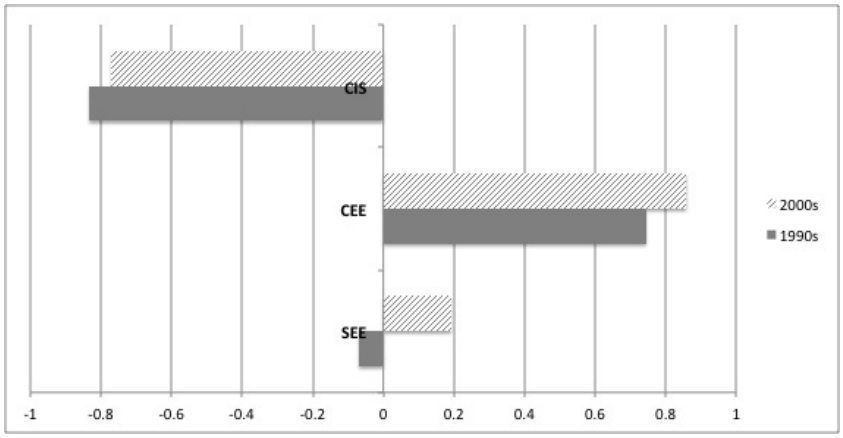

Figure 3: Average quality of governance in transition countries
Source: own calculations using data from World Governance Indicators. Note: The indicator is computed as the average inward governance score across six dimensions

flows, both through decreases in imports (less purchasing power) and exports (less demand from their main markets like the EU). Together, these developments have also reduced the potential of technological spillovers in these economies.

4 Method

4.1 Theoretical model

Following my theoretical conjectures in Section 2, I propose a model that accommodates the role of institutions in an endogenous growth framework. This model draws on Broda et al. (2006) and Grossman and Helpman (1991), extending their approach to incorporate interactions with institutional settings. I assume that the world is composed of n countries and that each of these economies utilizes labor, capital and intermediate inputs to produce a unique final good that is sold both in domestic and foreign markets. This is produced competitively in the final goods sector governed by the following production function:

$$Y = (AL)^{1-\theta} D^{\theta}, 0 < \theta < 1 \tag{1}$$

where L is the labor input, A is the quality changes over time and D is the range of

intermediate inputs that follow this specification:

$$D = \int_0^N [x_j^{\Psi} dj]^{1/\Psi}, \Psi > 1 \tag{2}$$

where Ψ measures the elasticity of substitution between various inputs of variety j, and N represents different varieties of inputs available at a certain time. However, in equilibrium , x_j would equal x, and manufacturers would employ equal quantities of each input. Thus, the production function would be given by:

$$Y = (AL)^{1-\theta}(Nx^{\Psi})^{\theta/\Psi} \tag{3}$$

Furthermore, let each intermediate input x be produced at a one-for-one ration with capital as in Broda et al.(2006). Subsequently, the total amount of capital (K) employed in production equals K=Nx. Substituting that in (3) yields:

$$Y = (AL)^{1-\theta}K^{\theta}N^{\left(\frac{1-\Psi}{\Psi}\right)\theta} \tag{4}$$

Thus, total factor productivity is given by:

$$F = A^{1-\theta}N^{\left(\frac{1-\Psi}{\Psi}\right)\theta} \tag{5}$$

However, the number of intermediate varieties depend on both domestic (S^d) and foreign sources of technology (S^f), as suggested by Coe and Helpman (1995):

$$F = A^{1-\theta}(\zeta_d S^d)^{\left(\frac{1-\Psi}{\Psi}\right)\theta}(\zeta_f S^f)^{\left(\frac{1-\Psi}{\Psi}\right)\theta} \tag{6}$$

yielding the baseline model:

$$logF = \eta + \delta_d \log S^d + \delta_f \log S^f \tag{7}$$

where $\delta_d = \frac{1-\Psi}{\Psi}\theta \log \zeta_d$ and $\delta_f = \frac{1-\Psi}{\Psi}\theta \log \zeta_f$

This specification can be extended further to include the channel of foreign direct investment as a source of potential spillovers:

$$logF_{it} = \eta_{it} + \delta_d \log S_{it}^{d} + \delta_{fm} \log S_{it}^{fm} + \delta_{ff} \log S_{it}^{ff}, \tag{8}$$

where S_{it}^{fm}represents the trade related spillovers and S_{it}^{ff} the FDI specific ones.

Finally, I allow for domestic institutional quality to have a direct impact on productivity and also act as a moderator for spillovers:

$$logF_{it} = \eta_{it} + \delta_d \log S_{it}^{d} + \delta_{fm} \log S_{it}^{fm} + \delta_{ff} \log S_{it}^{ff} + \gamma_{it} + \delta_{fm}^{\gamma}(\gamma_{it} * \log S_{it}^{fm}) + \delta_{ff}^{\gamma}(\gamma_{it} * \log S_{it}^{ff}) \tag{9}$$

where γ_{it} represents a measure of institutional quality, η_{it} captures both cross-country specific effects and exogenous technological progress over time. This model will be used as a base for my econometric estimations, which will include several institutional proxies and distinguish these effects across a sample of developed and transition economies.

4.2 Data and variables

To test the direct and moderating impacts of institutional quality on productivity, I employ a panel of 47 countries over the period 1990 to 2009. This includes 20 developed Western European and 27 transitional countries: 19 from Central and Eastern Europe and 8 from Central Asia (these are all former USSR states). The analysis is confined to the period 1990 to 2009 as for most transition countries 1990 is the first year of economic and political freedom, following the fall of the Berlin Wall. Prior to 1990, these countries were not open to trade or FDI. Thus, the inward flows of foreign goods and investments, which I postulate to carry R&D spillovers were mostly non-existent before 1990. To compute the technological spillovers I rely on R&D investment statistics for 25 OECD countries, which account for more than 82 percent of the world's R&D investment according to my computations. These countries will

constitute the main source of spillovers for both Western European and transition countries.

4.3 Measuring productivity and spillovers

Total factor productivity

GDP (in millions of 1990 PPP US$) and employment data (in thousands) are from the Total Economy Database (Groningen Growth and Development Centre). The physical capital stock values are computed using aggregated investment shares as a percentage of GDP (from the World Penn Tables 6.2) For computations of the capital stock in year t, I use the Perpetual Inventory Method (PIM).

R&D stocks

Domestic R&D stocks are computed using the gross domestic R&D investments (GERD) from OECD's Main Science and Technology Indicators database. Several missing values are interpolated taking into account the historical evolution of national GDP. Again, PIM is applied to the computation of R&D stocks. The initial stock is computed for the first available year (1980), while the subsequent yearly depreciation rate is fixed at 15 percent. In the case of non-OECD countries, I use the indicator GERD as a percentage of GDP (UNESCO Statistical Yearbooks, Eurostat and national statistics) and values for total GDP in constant 2000 $ PPP (World Development Indicators) to construct the yearly flows of GERD; the R&D stocks are computed using PIM and an identical depreciation rate.

International technological spillovers from trade and FDI

As a result of trade and investment activities, both domestic and foreign intermediate goods can be employed in a country i's production. The range of domestic intermediate goods produced can be estimated as the cumulative stock of R&D expenditures while the unobserved range of foreign intermediates is captured by a flow weighted foreign R&D matrix, where the flows are bilateral imports and inward FDI. This bears the assumption that FDI and trade

are complements rather than substitutes. There are several weighting schemes used in the literature; however, the results are quite robust regardless of the type employed (Krammer, 2010). As a result, I opt for similar weights to those of Ciruelos and Wang (2005):

$$S_{it}^{fm} = \sum_{j=1}^{n} \frac{M_{ijt}}{\sum_i X_{jit}} * S_{jt}^{F} \tag{10}$$

$$S_{it}^{ff} = \sum_{j=1}^{n} \frac{F_{ijt}}{\sum_i F_{jit}} * S_{jt}^{F} \tag{11}$$

where i represents the home or recipient country, while j is the foreign one. In equation (10) the fraction inside the summation represents the share of country i's imports (M_{ijt}) from j from the total exports of country j ($\sum_i X_{jit}$) in year t multiplied by the stock of foreign R&D of j (S_{jt}^{F}). Thus, the greater the R&D intensity of partner countries and the more intensive trade flows are, the greater the potential spillovers will be for the recipient country. A similar procedure is applied for FDI spillovers in equation (11). Hence, according to these equations, the higher the share of goods and inward FDI a country j receives from a developed and R&D intensive nation i, the bigger j's spillover will be. Data on trade flows comes from the IMF DOTS database, while FDI data are drawn from the World Development Indicators (World Bank), complemented by UNCTAD statistics. The foreign R&D stocks are computed using PIM and R&D investments from Main Science and Technology Indicators (OECD). Therefore, the R&D stocks of 25 OECD countries serve as a base for spillovers for both developed Western European as well as transition countries.

4.4 Institutional quality

In practice, measuring institutions is a daunting task. The three most common ways to quantify institutions across countries include: (1) data from surveys of international investors; (2) the governance and ease of doing business data sets developed by the World Bank; (3) political aspects that usually present little variance on the short term and capture the essence

of institutional settings of a country. In this paper, I adopt a mixed approach that relies on secondary sources of data and employs a battery of variables to capture the complexity of formal institutional aspects in a country. The variables considered are described below.

Governance

Data on various aspects of governance in a country come from the Worldwide Governance Indicators (WGI), a project run by the World Bank, which covers 212 countries and territories between since 1996. The data, collected from surveys of enterprises, experts and citizens, is especially useful when dealing with developing countries where information is scarce. I construct an average governance indicator (*avg_gov*) from the six components available, namely Voice and Accountability, Political Stability and Absence of Violence, Government Effectiveness, Regulatory Quality, Rule of Law and the Control of Corruption. These six components receive equal weights in the aggregate governance variable.

Economic freedom

Economic freedom encompasses the rights of individuals over their labor and property with minimal governmental restrictions and interventions. The Heritage Foundation's Index of Economic Freedom is an extremely useful tool for international comparisons on these issues covering in total 183 countries. The measure considered in this paper is an aggregated indicator (*econ_freed*) which includes 10 qualitative and quantitative factors with equal weights: property rights, freedom from corruption), fiscal freedom, government spending, business freedom, labor freedom, monetary freedom, trade freedom, investment freedom and financial freedom.

Intellectual property rights protection

With the rise of global trade agreements, research on the effect of international regulation of property rights (IPR) has received a lot of attention, and to this day, its policy implica-

tions remain controversial, especially in the area of developing nations. To measure IPR, I use data from Park (2008), which proposed an updated (up to 2005) and extended (includes 122 countries) intellectual property rights index (*ipr*) that quantifies the adoption of stronger patent laws and the composition of patent rights. This index provides a comparable quantitative indication of the strength of the patent systems across countries and it comprises five different scores for coverage, international treaties membership, duration of protection, enforcement and restrictions regarding patenting (Park, 2008). The original data has a five year frequency, and the indicator used in this paper employed yearly IPR values obtained through interpolation, under the assumption that IP regimes change slower than the proposed 5-year window.

Ease of doing business

The "ease of doing business" index (World Bank) provides a general assessment of a country's business environment and its pro-business institutional elements and reforms. It encompasses several categories that include starting a business, dealing with construction permits, employing workers, registering property, getting credit, paying taxes, protecting investors, international trade, contract enforcement and business closing procedures. I employ a normalized version of this indicator (*bus_ease*) that equals the maximum number of procedures required to open up a business across all countries minus the number of procedures in the country of interest divided by 30 (days). Thus, higher value of this indicator suggest better or easier regimes of doing business.

5 Empirical analysis

5.1 Econometric issues

Given the close movements of all these macroeconomic time series, one cannot ignore the problem of spurious regression that might arise when dealing with non-stationary variables.

Variable	Name	Summary Statistics					Panel Unit Root Tests		
		Obs	Mean	St.Dev	Min	Max	LLC	IPS	H
$logF$	log total factor productivity	910	2.00	0.43	0.68	2.82	20.33	-0.63	16.11***
$logS^{fm}$	log trade spillovers	940	5.37	2.53	0.00	10.13	17.95	-0.84	11.25***
$logS^{ff}$	log FDI spillovers	933	4.17	2.95	0.00	11.29	18.01	1.46	9.69***
$logS^{d}$	log domestic R&D	943	8.38	2.21	3.75	12.71	10.64	0.39	16.01***
avg_gov	average governance score	349	2.33	0.98	0.00	3.77	-7.58***	0.49	15.89***
$econ\_freed$	average freedom score	436	60.95	10.50	31.50	82.20	-8.80***	-0.47	13.81***
ipr	IPR index	395	3.78	0.81	1.20	4.67	-2.31**	1.08	8.91***
bus_ease	ease doing business	550	0.33	0.09	0.00	0.46	-1.12	-0.87	10.56***

Table 1: Descriptive statistics and panel unit root tests (1990-2009)

Notes: All tests include individual effects and individual linear trends. In their specification up to 4 lags were considered based on the Schwarz selection criterion. Hadri (H) is the only test which has stationarity as the null hypothesis, all the others have non-stationarity. Hadri allows also for heteroskedastic error terms.; †, ** and *** indicate variables that are significant at the 10%, 5% and respectively 1% levels

Estimated equations	Pedroni Tests		
	Panel v	Panel ρ	Group ρ
$logF\ logS^{d}$	0.06	1.40	3.17***
$logF\ logS^{fm}\ logS^{ff}\ logS^{d}$	6.87***	7.03***	9.67***
$logF\ logS^{fm}\ logS^{ff}\ logS^{d}\ avg\_gov$	11.08***	4.17***	4.98***
$logF\ logS^{fm}\ logS^{ff}\ logS^{d}\ econ\_freed$	23.68***	7.72***	9.60***
$logF\ logS^{fm}\ logS^{ff}\ logS^{d}\ ipr$	3.30***	10.46***	12.82***
$logF\ logS^{fm}\ logS^{ff}\ logS^{d}\ bus\_ease$	13.76***	8.65***	8.33***

Table 2: Panel cointegration tests(1990–2009)

Notes: The null hypothesis for these tests is no cointegration; the lag selection is automatic based on Schwarz information criterion and the tests use a Newey-West bandwidth selection with Bartlett kernel; †, ** and *** indicate variables that are significant at the 10%, 5% and respectively 1% levels

To explore this issues I employ several panel unit root tests proposed by Im et al. (2003); Levin et al. (2002) and Hadri (2000), which are superior to the ones based on individual time series, especially when these series are not very long (see Table 1)[1]. The results of these tests indicate that most of these variables are non-stationary. Hence, to estimate the effect of international R&D spillovers via FDI and trade on productivity and the impact of various institutional settings, one needs to find a cointegrating relationship between them.

In this case, panel cointegration is the most appropriate way to deal with *I(1)* series, as opposed to other methods, such as first differencing, which discards some valuable information in the process. To test whether there is a cointegrating relationship between the

[1]Two variables do not possess a time dimension: expropriation risk and institutional origins. Thus, I do not perform time series analysis for these variables.

variables in the model, I employ the three most powerful tests for a small t large N sample, proposed by Pedroni (1999)[2]. Their values and significance levels are reported in Table 2. Overall, in most cases, I reject the null hypothesis of no cointegration, so that the least-square estimator becomes "super-consistent"[3]. This makes it suitable for regression analysis using non-stationary variables.

5.2 Analysis and results

Given the availability of data across these variables (e.g., governance data is not available prior to 1996), the final dataset has an unbalanced panel structure. Pairwise correlations between main variables are reported in Table 3. They indicate potential collinearity issues between IPR, governance and, to a lesser extent, economic freedom, and the computed measures of spillovers. Additional collinearity tests using variance inflation factors (VIFs) and other diagnostic tests suggest that the risk of multicollinearity is increased significantly by the introduction of moderation (interaction) effects in the regressions and simultaneous consideration of all institutional proxies, as they exacerbate the collinearity between our variables of interest. In these cases VIF values well exceed the recommended threshold in the literature (10) and the reliability of the coefficients becomes questionable. Therefore, to minimize these potential estimation pitfalls, I will run the analysis bringing in one institutional proxy at a time, center the interaction variables, and run separate regressions for developed and transition economies in each scenario.

Throughout the analyses, I test various specifications using the full sample of 47 countries (*all*) and disentangle developed Western economies (*wec*) from Eastern European and Central Asian transition countries (*trc*) to identify potential differences in terms of how spillovers

[2]These seven residual-based tests are based on the null hypothesis of no cointegration and allow for heterogeneous cross sectional variance. Pedroni (2004) runs various Monte Carlo experiments and suggests that the parametric group-ρ statistic and panel-ρ statistic appear to have the highest power, followed by the panel-v statistic.

[3]Converges faster to the true estimate of the parameter of the population than in the case of stationary variables associated with the usual OLS requirements

	Variable	1	2	3	4	5	6	7	8
1	logF	1.00							
2	$logS^d$	0.35	1.00						
3	$logS^{fm}$	0.59	0.76	1.00					
4	$logS^{ff}$	0.67	0.38	0.63	1.00				
5	avg_gov	0.79	0.50	0.68	0.60	1.00			
6	ipr	0.42	0.40	0.65	0.60	0.49	1.00		
7	bus_ease	0.45	-0.20	0.26	0.38	0.20	0.37	1.00	
8	econ_freed	0.76	0.17	0.49	0.58	0.81	0.38	0.18	1.00

Table 3: Pairwise correlations for the main variables (1990-2009)

and institutions impact productivity levels[4]. By using a fixed effects model I deal with this unobserved heterogeneity and isolate the effect of the variables of interest.

I start with a simple model (Model 1, Table 4) which looks at the direct impact of institutional quality, proxied by average governance scores, while controlling for the influence of R&D spillovers from trade and FDI activities, domestic investments in R&D, as well as other sources of unobserved heterogeneity across countries by using a fixed effects model. Both sources of spillovers and the domestic R&D stock contribute to productivity growth. However, upon consideration of institutional features (e.g., governance) the domestic R&D stock becomes insignificant and the spillovers from FDI become significant at only 10 percent, given the high correlation between them. Average governance is correlated robustly with productivity levels across countries and a one point increase in this indicator translates into an average of 11% increase in productivity. Model 2 tests the indirect effects of governance of spillovers from trade activities. The interaction coefficient is negative and highly statistically significant (at 1 percent) suggesting that greater governance levels reduce the impact of spillovers on domestic productivity of countries. Similar effects, although a bit lower in magnitude, are obtained in Model 3, where I test the interaction between governance quality and spillovers from FDI. Finally, results hold upon introduction of all these interactions

[4]Besides the obvious differences between transition and developed economies, there is also significant heterogeneity within both groups. In Western economies, the core of EU-15 led by Germany, France and the UK, is more productive than the Southern peripheries, represented by Greece, Spain and Portugal. Similarly, countries from Central and Eastern Europe (Hungary, Slovenia, Czech Republic, etc.) are the forerunners of the transition pack, while Central Asian states (Armenia, Azerbaijan, Kazakhstan and others) are still fine-tuning their recipes for success. Moreover, it would be difficult to justify that composition or in R&D intensity of trade and FDI inflows of transition and Western European nations are similar.

(Model 4) despite the inherent collinearity issues. Overall the results support my hypotheses 1 and 3b regarding the direct and indirect effects of institutions on productivity

Next, I seek to distinguish the effects of institutions contingent on the level of economic development. Model 5 suggests that institutions still bear positive effects on productivity in the case of developed nations. However, the indirect effects are both smaller in size and less prominent statistically. Only the interaction between trade spillovers and governance is statistically significant at 10% providing weak support for Hypothesis 3a. Similarly, the coefficients for direct effects of spillovers on productivity are much weaker throughout the estimations (Model 5-8). Therefore, domestic R&D efforts appear to be the main driver of productivity in Western Europe. In contrast, transition economies appear to benefit much more from exposure to trade and FDI (Model 9-12). Especially in the case of FDI spillovers, transition economies appear to gain significantly, likely driven by a larger technological distance between incoming MNEs and domestic incumbents, yielding a larger potential for spillovers. Good governance is associated with higher productivity for these countries as well, although its impact is not greater overall (thus, not confirming my second hypothesis). However, both trade and FDI related spillovers appear to be negatively moderated by governance quality, suggesting that as transition countries improve their governance structure, the impact of spillovers on productivity is diminishing. These results are consistent with hypotheses 3b and 4.

Models 13 through 24 perform similar tests using a different institutional variable, namely the average score for economic freedom of a country, proposed by the Heritage Foundation's Index of Economic Freedom (Table 5). Again, I start with a pooled sample of all 47 countries and show that in general, countries equipped with more economic freedom are also benefiting from higher levels of productivity (Models 13-16). Moreover, the results support again hypothesis 3b according to which institutional quality moderates negatively the influence of spillovers on productivity. Furthermore, I compare these results in the case of developed and transition economies and find for Western Europe, both economic freedom and spillovers

Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**	**Model 9**	**Model 10**	**Model 11**	**Model 12**
	all	*all*	*all*	*all*	*wec*	*wec*	*wec*	*wec*	*trc*	*trc*	*trc*	*trc*
$logS^{fm}$	0.134***	0.254***	0.132***	0.243***	0.014+	0.029	0.014+	0.026	0.171***	0.275***	0.182***	0.251***
	[0.010]	[0.020]	[0.009]	[0.021]	[0.008]	[0.026]	[0.008]	[0.027]	[0.014]	[0.025]	[0.013]	[0.026]
$logS^{ff}$	0.010+	0.011**	0.065***	0.040**	0.006**	0.005+	-0.016	-0.01	0.007	0.013+	0.110***	0.083***
	[0.005]	[0.005]	[0.016]	[0.016]	[0.003]	[0.003]	[0.011]	[0.012]	[0.007]	[0.007]	[0.022]	[0.024]
avg_gov	0.103***	0.285***	0.149***	0.294***	0.086**	0.004	0.064	0.008	0.051	0.236***	0.121**	0.229***
	[0.038]	[0.045]	[0.040]	[0.045]	[0.034]	[0.062]	[0.042]	[0.063]	[0.047]	[0.059]	[0.047]	[0.057]
avg_gov * $logS^{fm}$		-0.056***		-0.051***		0.014+		0.013		-0.057***		-0.040***
		[0.008]		[0.009]		[0.008]		[0.009]		[0.012]		[0.013]
avg_gov * $logS^{ff}$			-0.023***	-0.012+			0.003	0.002			-0.048***	-0.033***
			[0.006]	[0.006]			[0.004]	[0.004]			[0.010]	[0.011]
$logS^{d}$	-0.015	0.035	0.005	0.041+	0.129***	0.126***	0.130***	0.127***	0.059+	0.066**	0.109***	0.098***
	[0.022]	[0.022]	[0.023]	[0.022]	[0.019]	[0.018]	[0.019]	[0.019]	[0.034]	[0.032]	[0.034]	[0.033]
constant	1.038***	0.312	0.805***	0.251	0.690***	0.984***	0.739***	0.985***	0.367	0.014	-0.211	-0.283
	[0.210]	[0.222]	[0.215]	[0.223]	[0.150]	[0.224]	[0.159]	[0.225]	[0.289]	[0.282]	[0.297]	[0.291]
N	304	304	304	304	107	107	107	107	197	197	197	197
R^2	0.55	0.62	0.57	0.62	0.69	0.70	0.69	0.70	0.61	0.66	0.66	0.68
AIC	-651.8	-697.0	-664.1	-699.3	-481.9	-483.4	-480.9	-481.6	-370.1	-392.9	-393.0	-401.7
BIC	-633.2	-674.7	-641.8	-673.3	-468.5	-467.4	-464.8	-462.9	-353.7	-373.2	-373.3	-378.7

Table 4: Governance quality, R&D spillovers and productivity. Panel estimations (1990-2009)

Notes: The dependent variable is log TFP; †, ** and *** indicate variables that are significant at the 10%, 5% and respectively 1% levels; standard errors are reported in parenthesis below the coefficients; All estimated models contain unreported fixed effects and use White standard errors.

have marginal effects on productivity. The main driver of the latter remains domestic R&D efforts. The interaction terms between institutional quality and spillovers are very small in magnitude and not statistically significant. Oppositely, both spillovers (especially trade related ones) and economic freedom have a strong statistical influence on productivity in transition countries. Moreover, the interaction terms indicate that for transition countries greater levels of economic freedom diminishes the effect of spillovers, as they are not able to freely imitate foreign technologies. These results are very similar to the ones obtained using governance quality as a measure of institutions.

Another variable that has received a significant amount of attention in the literature is the strength of IPR regimes. In Table 6 regressions 25 through 36 synthesize these results. In terms of direct effects, a higher IPR regime is associated with higher productivity, especially in developed economies (Models 29-32). A one point improvement on the scale of IPR rights will result in a 19.72% increase in productivity levels in developed nations and about 19% in transition ones. Therefore, the effects appear similar in magnitude for the two sets of countries, although for transition economies the statistical significance tends to be lower. When analyzing the interaction between IPR regimes and the spillover variables from FDI and trade the results are opposite to each other for the two sets of countries. In the case of Western economies, interactions are all positive suggesting that stronger IPR regimes coupled with larger inflows of FDI and trade will boost domestic productivity. However, transition economies exhibit a negative interaction between the strength of IPR regimes and their ability to harness spillovers for productivity growth (Models 34-36). These findings suggest that for developed nations high IPR institutions are associated with higher effects of spillovers while for transition economies the opposite is true. A possible explanation is the structural difference in composition of FDI and trade flows between the two sets of countries. Moreover, these findings are consistent with previous results (Falvey et al., 2006) and arguments in the literature (Grossman and Lai, 2002; Chaudhuri et al., 2003). Although the negative effects might be dampened across industries with losers and winners on both

Variables	**Model 13**	**Model 14**	**Model 15**	**Model 16**	**Model 17**	**Model 18**	**Model 19**	**Model 20**	**Model 21**	**Model 22**	**Model 23**	**Model 24**
	all	*all*	*all*	*all*	*wec*	*wec*	*wec*	*wec*	*trc*	*trc*	*trc*	*trc*
$logS^{fm}$	0.105***	0.302***	0.106***	0.302***	0.017**	0.049	0.016**	0.054	0.132***	0.323***	0.134***	0.320***
	[0.009]	[0.022]	[0.009]	[0.025]	[0.008]	[0.051]	[0.008]	[0.053]	[0.013]	[0.034]	[0.013]	[0.034]
$logS^{ff}$	0.011***	0.011***	0.096***	0.012	0.005+	-0.004	-0.007	-0.012	0.008	0.015**	0.060+	0.03
	[0.004]	[0.004]	[0.020]	[0.021]	[0.003]	[0.003]	[0.023]	[0.024]	[0.006]	[0.006]	[0.032]	[0.030]
econ_freed	0.008***	0.023***	0.013***	0.023***	0.000	0.004	0.000	0.004	0.009***	0.021***	0.010***	0.021***
	[0.001]	[0.002]	[0.001]	[0.002]	[0.001]	[0.006]	[0.003]	[0.006]	[0.001]	[0.002]	[0.002]	[0.003]
econ_freed * $logS^{fm}$		-0.003***		-0.003***		0.000		-0.001		-0.003***		-0.003***
		[0.000]		[0.000]		[0.001]		[0.001]		[0.001]		[0.001]
econ_freed * $logS^{ff}$			-0.001***	0.000			0.000	0.000			-0.001	0.000
			[0.000]	[0.000]			[0.000]	[0.000]			[0.000]	[0.000]
$logS^{d}$	-0.013	0.025+	0.016	0.025	0.135***	0.130***	0.135***	0.131***	0.046+	0.048**	0.059**	0.052**
	[0.016]	[0.015]	[0.017]	[0.016]	[0.017]	[0.019]	[0.017]	[0.019]	[0.025]	[0.023]	[0.026]	[0.024]
constant	0.929***	-0.272	0.425**	-0.275	0.834***	0.629+	0.850***	0.642+	0.248	-0.505**	0.024	-0.557**
	[0.152]	[0.183]	[0.187]	[0.190]	[0.120]	[0.341]	[0.181]	[0.345]	[0.217]	[0.237]	[0.255]	[0.259]
N	388	388	388	388	147	147	147	147	241	241	241	241
R^2	0.63	0.71	0.65	0.71	0.68	0.68	0.68	0.68	0.68	0.73	0.69	0.73
AIC	-900.9	-990.4	-919.6	-988.4	-641.2	-639.6	-639.2	-637.8	-492.3	-527.7	-493.3	-526.0
BIC	-881.1	-966.6	-895.9	-960.7	-626.2	-621.7	-621.3	-616.8	-474.9	-506.8	-472.4	-501.6

Table 5: Economic freedom, R&D spillovers, and productivity. Panel estimations (1990-2009)

Notes: The dependent variable is log TFP; †, ** and *** indicate variables that are significant at the 10%, 5% and respectively 1% levels; standard errors are reported in parenthesis below the coefficients; All estimated models contain unreported fixed effects and use White standard errors.

sides (Smarzynska-Javorcik, 2004), overall there seems to be a negative effect on aggregated productivity for transition economies.

Table 7 concludes the empirical exercise by employing a measure of business friendliness (i.e., easiness to do business, or how pro-business the institutional environment is), which should be especially salient for FDI-related spillovers. Given that trade and FDI flows could act both as substitutes and complements, the impact of easiness to do business on trade spillovers is not clear even in theory. These results of these interactions (Models 37 to 48) are in accordance with the view that trade and investments are imperfect complements. Overall, the quality of the business environment appears to be weakly correlated with productivity improvements (Models 37-40), especially when the moderating effects are not considered. In terms of direct effects, it is clear that developed (Western) economies tend to benefit from it (Models 41-44) to a greater extent then transition economies (Models 45-48). However, in terms of indirect effects, interactions between ease of doing business and both trade-related and FDI-related spillovers are positive and statistically significant for both sets of countries, suggesting that the benefits of spillovers are clearly affected by institutional progress in this domain. Overall these results support my postulated hypotheses regarding the generic direct and indirect effects of institutions on productivity.

To formally test Hypotheses 2 and 4 I run additional regressions with the same specifications across all institutional proxies and allowing for interaction effect with a dummy variable representing transition countries. These regressions are not reported in the paper in detail due to space constraints, but they are synthesized in the Conclusions section (Table 8). Overall, I find no significant difference in magnitude between the direct effects of institutions on productivity across the two groups of countries (transition and developed economies). However, in terms of moderating effects these tend to be significantly larger for transition countries, especially those via spillovers from trade, in accordance with my fourth hypothesis.

Finally, I perform several robustness checks to test the validity of these results. First, I

Variables	**Model 25**	**Model 26**	**Model 27**	**Model 28**	**Model 29**	**Model 30**	**Model 31**	**Model 32**	**Model 33**	**Model 34**	**Model 35**	**Model 36**
	all	*all*	*all*	*all*	*wec*	*wec*	*wec*	*wec*	*trc*	*trc*	*trc*	*trc*
$logS^{fm}$	0.130***	0.165***	0.132***	0.147***	0.027***	0.112***	0.035***	0.071**	0.214***	0.300***	0.204***	0.295***
	[0.008]	[0.023]	[0.008]	[0.025]	[0.007]	[0.029]	[0.008]	[0.033]	[0.015]	[0.043]	[0.015]	[0.041]
$logS^{ff}$	0.002	0.001	0.022**	0.019+	0.000	-0.002	-0.041***	-0.026***	0.005	0.010	0.082***	0.082***
	[0.004]	[0.004]	[0.010]	[0.011]	[0.003]	[0.003]	[0.008]	[0.009]	[0.007]	[0.006]	[0.023]	[0.023]
ipr	-0.003	0.043	0.013	0.031	0.186***	0.193***	0.036***	0.161***	0.174***	0.104+	0.019	0.135***
	[0.008]	[0.030]	[0.011]	[0.030]	[0.023]	[0.038]	[0.013]	[0.039]	[0.064]	[0.053]	[0.015]	[0.051]
ipr * $logS^{fm}$		-0.008		-0.004		0.032***		0.022***		-0.022**		-0.021**
		[0.005]		[0.006]		[0.006]		[0.007]		[0.009]		[0.009]
ipr * $logS^{ff}$			-0.006**	-0.005+			0.010***	0.006***			-0.023***	-0.023***
			[0.002]	[0.003]			[0.002]	[0.002]			[0.006]	[0.006]
$logS^{d}$	0.049***	0.055***	0.057***	0.058***	0.102***	0.139***	0.115***	0.137***	0.146***	0.188***	0.126***	0.155***
	[0.010]	[0.011]	[0.010]	[0.011]	[0.010]	[0.013]	[0.011]	[0.013]	[0.031]	[0.033]	[0.031]	[0.033]
constant	0.731***	0.472**	0.587***	0.492***	1.290***	1.555***	1.017***	1.427***	-1.045***	-1.663***	-0.682**	-1.455***
	[0.130]	[0.189]	[0.121]	[0.189]	[0.083]	[0.141]	[0.082]	[0.147]	[0.350]	[0.489]	[0.340]	[0.464]
N	352	352	352	352	206	206	206	206	146	146	146	146
R^2	0.62	0.63	0.63	0.63	0.82	0.78	0.77	0.79	0.71	0.70	0.73	0.74
AIC	-890.0	-892.8	-895.9	-894.3	-814.4	-771.2	-767.0	-776.8	-322.7	-318.7	-330.6	-334.9
BIC	-866.8	-869.6	-872.7	-867.3	-794.5	-751.2	-747.0	-753.5	-304.8	-300.8	-312.7	-314.0

Table 6: Intellectual property rights protection, spillovers, and productivity. Panel estimations(1990-2009)

Notes: The dependent variable is log TFP; †, ** and *** indicate variables that are significant at the 10%, 5% and respectively 1% levels; standard errors are reported in parenthesis below the coefficients; All estimated models contain unreported fixed effects and use White standard errors.

Variables	Model 37	Model 38	Model 39	Model 40	Model 41	Model 42	Model 43	Model 44	Model 45	Model 46	Model 47	Model 48
	all	*all*	*all*	*all*	*wec*	*wec*	*wec*	*wec*	*trc*	*trc*	*trc*	*trc*
$logS^{fm}$	0.028***	-0.005	0.033***	0.011	0.039***	0.123***	0.023**	-0.047	0.021***	-0.017	0.027***	-0.003
	[0.006]	[0.012]	[0.006]	[0.012]	[0.011]	[0.032]	[0.010]	[0.037]	[0.008]	[0.016]	[0.008]	[0.016]
$logS^{ff}$	0.036***	0.031***	0.034**	-0.027	0.000	-0.004	0.082***	0.064***	0.047***	0.040***	-0.035	-0.032
	[0.005]	[0.006]	[0.017]	[0.017]	[0.004]	[0.004]	[0.013]	[0.016]	[0.008]	[0.008]	[0.023]	[0.022]
bus_ease	0.154	0.266	0.251+	0.463**	0.008	2.965***	0.946***	2.067***	0.153	0.269	0.271	0.552**
	[0.123]	[0.178]	[0.151]	[0.183]	[0.132]	[0.569]	[0.190]	[0.593]	[0.158]	[0.221]	[0.191]	[0.233]
bus_ease * $logS^{fm}$		0.133***		0.085**		0.420***		0.190**		0.152***		0.117**
		[0.041]		[0.042]		[0.079]		[0.096]		[0.056]		[0.056]
bus_ease * $logS^{ff}$			0.194***	0.166***			0.222***	0.169***			0.226***	0.204***
			[0.043]	[0.045]			[0.034]	[0.043]			[0.059]	[0.060]
$logS^{d}$	0.062***	0.048**	0.049***	0.041**	0.137***	0.151***	0.157***	0.159***	0.050+	0.041	0.039	0.034
	[0.019]	[0.019]	[0.018]	[0.019]	[0.019]	[0.018]	[0.017]	[0.017]	[0.029]	[0.029]	[0.028]	[0.028]
constant	1.059***	1.282***	1.289***	1.399***	0.619***	1.663***	0.885***	1.295***	1.102***	1.269***	1.299***	1.407***
	[0.178]	[0.189]	[0.182]	[0.189]	[0.134]	[0.231]	[0.127]	[0.241]	[0.252]	[0.257]	[0.251]	[0.255]
N	501	501	501	501	182	182	182	182	319	319	319	319
R^2	0.26	0.27	0.29	0.29	0.69	0.73	0.75	0.76	0.24	0.26	0.28	0.29
AIC	-614.7	-623.9	-633.8	-636.2	-636.2	-663.0	-674.7	-677.0	-266.3	-272.0	-279.6	-282.2
BIC	-593.6	-598.6	-608.5	-606.7	-620.2	-643.8	-655.4	-654.5	-247.5	-249.4	-257.0	-255.8

Table 7: Ease of doing business, spillovers, and productivity. Panel estimations (1990-2009)

Notes: The dependent variable is log TFP; †, ** and *** indicate variables that are significant at the 10%, 5% and respectively 1% levels; standard errors are reported in parenthesis below the coefficients; All estimated models contain unreported fixed effects and use White standard errors.

analyze also the effects of direct institutional origins and outcomes on productivity and interactions with spillovers (only trade spillovers for simplicity). These results are not reported in the paper due to space constraints, but are available upon request. In terms of origins of the legal systems, Western Europe hosts four legal systems (French, German, Scandinavian and Anglo-Saxon), while the Eastern European and Central Asian nations replaced their socialist system and re-adopted their pre-WWII judicial systems (either French or German based). The estimation results suggest that countries with French based legal systems enjoy positive effects both in the full, developed and transition sample , while on aggregate those with German legal tradition have lower spillovers, except when these countries are developed Western European states, like Germany or Austria. Throughout these regressions, Scandinavian tradition is positively correlated with spillovers, while Common Law has the opposite effect.

For institutional outcomes, I examine the effects of expropriation risk using the index developed by McArthur and Sachs (2001), the infant mortality statistics and a measure of human capital (i.e., tertiary education) both provided by the UN Statistics. Developed countries with a low expropriation risk enjoy higher spillovers from both trade and FDI, while for transition countries things are ambiguous and the coefficients are not statistically significant, suggesting a less robust relationship. Low infant mortality, a direct result of institutional advancements in less developed countries, has strong positive effects on both productivity and the relationship with spillovers in the case of all countries. Besides affecting directly the labor force of a country, this measure also reflects indirectly the availability of human capital that ensures a successful absorption of technological content from abroad. Lastly, countries with larger population with tertiary education have higher productivity and are able to utilize better the potential spillovers from trade and FDI. The statistical evidence as well and the magnitude of the effects are more important in the case of transition countries, where technical education is a strong heritage from past decades and an important component of absorptive capacity that compensates for lower R&D investments.

Second, I perform a couple of tests regarding methodological choices made in this analysis. I test for non-linear direct effects of institutions on productivity, and find evidence of non-linear relationships only in the case for the full sample only in the case of institutions related to economic freedom. Moreover, I perform factor analysis on the four formal institutions considered. The four variables load less than satisfactory upon considering up to two factors, and the values for Cronbach's alpha (0.21 and respectively 0.31) confirm the below standard reliability of these composite indicators, partly due to significant decreases in the sample size upon simultaneous consideration of these factors (below 100 observations per group of countries). Despite these pitfalls, the results of these regressions confirm the core results of the paper (direct positive effects of institutions on spillovers; positive weak moderation of spillovers effects on productivity in the case of developed countries; negative and stronger moderation of spillovers effects on productivity in the case of transition countries).

6 Discussion and conclusions

Productivity and, more generally, economic growth remain at the heart of any policy agenda, especially in the wake of the crisis. Knowing that much of the variation in GDP and productivity differentials across countries can be attributed to innovation and new technologies, many policymakers seek to maximize technological benefits from both domestic (i.e., R&D efforts within the country) and external sources (i.e., via spillovers) that are accessible through foreign trade and investments (Krammer, 2010). In parallel, formal and informal institutional settings are found to spur innovation, productivity, economic performance alike (Dixit, 2009), suggesting that developing nations stand to gain significantly from improving their institutional environments. Despite numerous examinations of the effect of institutions on economic growth, we lack sufficient knowledge on the mechanisms through which institutions affect growth, their relationship with productivity and foreign technological spillovers, and impact across different countries and institutional elements.

Institutional proxies	Direct effect on productivity	Moderating effect via trade spillovers	Moderating effect via FDI spillovers
Institutions			
1. Governance	+ (all)	-(trc)	-(trc)
2. Economic freedom	+ (trc)	- (trc)	
3. IPR	+ (all)	+ (wec); - (trc)	+(wec); -(trc)
4. Ease doing business	+ (wec)	+ (all)	+ (all)
Institutional outcomes			
5. Expropriation risk		- (wec)	
6. Tertiary education	+ (all)	+ (all)	+ (all)
7. Low infant mortality	+ (all)	+ (all)	+ (all)

Table 8: Summary of results

Note: This table lists only statistically significant results and the sign (+ or -) of the estimated direct or moderating effect of these variables; wec refers to Western European countries, while trc refers to transition countries from Eastern Europe and Central Asia. Shaded shells represent cases in which the estimated coefficients are larger (statistically significant)in the case of transition countries than developed nations.

Seeking to answer these questions, this study has focused on the direct and moderating effects of formal institutions on productivity. Challenging the existing policy consensus institutional quality and reforms prescribed by academics and global organizations (e.g., World Bank, WTO) for emerging markets, this study explores the heterogeneous effects of multiple institutions on productivity and spillovers, rather than focus on a single institutional aspect (say IPR). The results of my empirical analysis confirm that the effects of institutions on productivity differ across development levels and institutional proxies considered (Table 8). First, in terms of direct effects, good institutions impact positively productivity levels in most cases, in accordance with my first hypothesis and the existing consensus in the literature (i.e., better institutions are growth and productivity enhancing). Some of these effects are prevalent in the case of transition economies (governance, economic freedom), while others (ease of doing business and expropriation risk) work better for developed countries. Second, in line with my theoretical conjectures, I find that institutional quality moderates the effects of foreign technological spillovers on productivity. However, these indirect effects vary across institutional elements and countries considered. Institutions that regulate the business environment (ease of doing business) appear to interact positively with both trade and FDI spillovers in determining productivity levels, confirming my Hypothesis 3a. Likewise, IPR regulations have positive moderating effects in the case of developed Western economies, but

negative ones for transition countries (Hypothesis 3b). These negative moderation effects are also found for governance quality and economic freedom in the case of transition economies.

These findings suggest different policy and economic implications for the two sets of countries. For developed, Western economies institutional quality does not moderate the relationship between spillovers and productivity, except when the institutional aspects considered are clearly linked with technologies (i.e., the strength of IPR regimes) or incoming FDI (i.e., ease of doing business). In these cases, better institutions enhance the effects of technological spillovers on productivity, as expected. This is due to the already existing high level of institutional quality in this countries, yielding very small marginal gains form further institutional upgrades. Thus, in these cases, other factors besides institutions are more likely to prevail in firm's decision to export or invest (e.g., geography, historical ties, profit margins, size of markets, etc.) which in this study are controlled for through the fixed effects estimators.

However, for transition economies, institutions related to FDI appear to positively moderate this relationship, while in the case of the rest negative moderation takes place. This effect results from a smaller scope for imitation of foreign technologies which lowers the absorptive capacity of domestic firms, an increase in competition with foreign firms for existing financial resources, and a less appealing image as a destination for resource- and cost reducing- FDI as a result of higher legislative standards (e.g., labor, environmental issues, etc.). Given these opposite effects, transition economies are ultimately facing a trade-off: on one hand institutional upgrading has direct benefits on productivity, encouraging domestic private innovation and the flows of technologies via trade and FDI, while on the other it reduces the ability of domestic firms to catch-up through free imitation, and threatens their competitive position through liberalization, and increased competition (for products, customers, innovation etc.) in these markets. Recent examples of emerging economies (e.g., China, Brazil) adopting a cautious path of institutional reform validate this conjecture, complementing the calls for stronger domestic innovation systems in the literature as a sustainable way to spur

growth in these countries (Furman and Hayes, 2004; Lundvall, 2007; Krammer, 2009).

While this study advances our knowledge on the relationship between institutions on productivity, it has also several limitations, which can serve a starting point for future research. First, there are other available proxies for formal institutional that have not been included in this study. The current focus on four institutional aspects is partly driven by their popularity in the extant literature combined with issues of data availability for transition countries. However, future studies could adopt different institutional proxies (e.g., bankruptcy laws, labor regulations, etc.) that are salient for technological spillovers from trade or FDI. Second, this study is grounded in the economic tradition of examining formal aspects of institutions that are commonly related to legislative measures that set the "rules of the game". An interesting addition to the literature would be to develop an integrative framework for institutional analysis, one that incorporates also the effects of informal institutions on productivity and economic growth. Previous studies have examined the general impact of informal settings such as cultural values on innovation and growth. However, their generality and prescriptions remain limited. Third, this type of empirical analysis could benefit from a sustained effort to develop new measures of institutional quality, one that maximizes both time and cross-country variation. The availability of institutional data could be significantly improved through new and better institutional measures and increased cross-country coverage that will include emerging economies from Africa, South-East Asia and the Middle East. Fourth, preliminary tests indicate that the effects of some institutional elements could be non-linear. An interesting question for future research would be to investigate closely the non-linearity of these relationships across a wide range of development levels. Finally, the concept of institutions is a complex and multifaceted one, evolving slowly over time and intrinsically related to changes in both technological and economic realm. More research is needed on the reverse relationship between economic and technological progress and institutional upgrades.

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