SHORT PAPER

CAN INDUSTRIAL POLICY BUY IDEAS?
INVESTMENT PROMOTION AND INNOVATION

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Abstract:

This paper argues that innovation can be facilitated by policies promoting inflows of foreign direct investment. It examines the relationship between national investment promotion efforts targeting particular sectors and the number of patent applications (or patents granted) for innovations involving at least one local inventor filed at the US Patent and Trademark Office in the technology class belonging to the targeted sector. The difference-in-differences results suggest that innovation increases in sectors explicitly targeted by investment promotion agencies. This relationship is stronger for more R&D-intensive industries belonging to the targeted sector. Focusing on an interaction between an industry characteristic and the policy instrument allows to control for country-sector-year fixed effects that absorb all the unobservables that may determine the choice of targeted sectors in a given year in a given country.

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1. Introduction

Most countries view promoting innovation as an important policy objective. For instance, the *G20 2016 Innovation Action Plan* states "We, the G20 members, agree that innovation is one of the key driving forces of global sustainable development, playing a fundamental role in promoting economic growth, supporting job creation, entrepreneurship and structural reform, enhancing productivity and competitiveness, providing better services for the citizens and addressing global challenges. The G20 members aim to encourage innovation through practical actions to promote sustainable economic growth today and lay a solid foundation for tomorrow."[1] Many policy instruments are used to promote innovation.[2]

This paper argues that innovation can also be facilitated by policies promoting inflows of foreign direct investment (FDI). There is ample evidence suggesting that multinational firms are heavily involved in creation of new knowledge through their engagement in research and development (R&D) activities.[3] Although in the past decades, R&D activities of multinational corporations mainly took place at their headquarters, this is no longer the case. For instance, according to the Bureau of Economic Analysis, US companies increased the share of R&D conducted in their foreign affiliates from 6% in 1982 to 14% in 2004. During the same time period, US public companies increased the share of patents involving an inventor located abroad from 6 to 13% (Kerr and Kerr 2018).[4]

There is also evidence that multinationals transfer knowledge and new technologies to their foreign subsidiaries (Arnold and Javorcik 2009; Javorcik and Poelhekke 2017) and that foreign affiliates introduce more new products and innovate more than domestic firms (Brambilla 2009; Guadalupe

[1] The Innovation Action Plan was agreed by the G20 countries in their Hangzhou Summit in September 2016, http://www.g20.utoronto.ca/2016/160905-innovation.html

[2] These include: fiscal incentives for R&D, direct support to firm R&D and innovation, policies for training and skills, entrepreneurship policy, technical services and advice, cluster policy, policies to support collaboration, innovation network policies, public procurement policies, pre-commercial procurement, and innovation inducement prizes (Edler and Fagerberg 2016).

[3] In 2002, 700 firms, 98 percent of which are multinational corporations, accounted for 46 percent of the world's total R&D expenditure and 69 percent of the world's business R&D (UNCTAD 2005).

[4] A survey of the world's largest R&D investors, conducted in 2004-5 by UNCTAD, revealed that the average respondent spent 28 percent of its 2003 R&D budget abroad, including in-house expenditure by foreign affiliates and extra-mural spending on R&D contracted to other countries (UNCTAD 2005).

et al. 2012). By increasing competition and engaging in cost discovery in host countries, multinationals may also induce more innovation by their domestic competitors. By sharing product information and production-related know-how, multinationals may additionally lower the costs of innovation and product upgrading on the part of the local suppliers.[5]

The task of attracting FDI inflows is typically given to national Investment Promotion Agencies (IPAs), who aim to lower the costs of investing in their country by providing potential foreign investors with information about business opportunities, laws and regulations, bureaucratic procedures and potential business partners. Recent evidence suggest that investment promotion leads to higher FDI flows, especially in countries in which red tape and information asymmetries are likely to be severe (Javorcik and Harding 2011; Carballo et al. 2020; Crescenzi et al. 2021). Most IPAs emphasize specific sectors to attract FDI, as sector targeting is hailed to be best practice by investment promotion professionals (Loewendahl 2001; Proksch 2004).

The focus on priority sectors followed by most IPAs is the cornerstone of our identification strategy, which examines whether sectors targeted by IPAs in their investment promotion efforts see an increase in patenting activity relative to the rest of the economy.[6] We use the unique FDI sector promotion data gathered by the World Bank, which include time-varying information on the specific sectors that were selected by IPAs in their investment promotion efforts. The data are very comprehensive in their coverage and include all country income groups and geographic regions. We complement this dataset with very detailed patent data from PATSTAT (Autumn 2019 version), which allows us to observe the number of patent applications and patents granted by country, sector and time. It also allows us to identify countries where inventors, associated with a particular patent, are located and the country from which the patent application has been made. We use both the number of patents as well as the number of patent *families* applied or granted.[7]

[5] For instance, Javorcik, Lo Turco and Maggioni (2018) find that Turkish firms in sectors and regions more likely to supply foreign affiliates tend to introduce more complex products, where complexity is captured using a measure developed by Hausmann and Hidalgo (2009).
[6] A similar strategy has been used by Harding and Javorcik (2011 and 2012).
[7] A *patent family* is "a set of patents taken in various countries to protect a single invention (when a first application in a country – the priority – is then extended to other offices)." (OECD 2001, page 60) In other words, a patent family is "the same invention disclosed by a common inventor(s) and patented in more than one country " (USPTO 2009).

Our data set covers 90 countries and 64 sectors during the period 1980-2010. Fifty three of these countries engage in sector targeting and thirty are both engaged in targeting and innovate.

In our analysis, we relate the number of patent applications or patent granted by the US Patent and Trademark Office (US PTO) to the country's FDI promotion activities in the sector to which these patents are connected. As we are primarily interested in the impact of investment promotion on local innovation, our analysis focuses on patents with at least one inventor residing in the country engaged in FDI promotion. We consider separately patent applications filed by entities from the country in question and patents filed by entities located anywhere in the world (e.g., by headquarters of the multinational whose foreign affiliate employed an inventor).

Our empirical analysis follows a difference-in-differences approach and investigates whether sectors explicitly targeted by IPAs innovate more in the post-targeting period, relative to the pre-targeting period and non-targeted sectors. In the baseline specification, we control for country-sector, sector-year, and country-year fixed effects. The most importance threat to our identification is the possible endogeneity of the targeting decision. It could be that IPAs target sectors that have already experienced innovation or are likely to do so in the future. We address this concern by asking a more nuanced question: is the impact of investment promotion larger in more R&D-intensive industries? As industries are more disaggregated units than sectors targeted by IPAs, focusing on an interaction term allows us to control for country-sector-year fixed effects that will absorb all unobservables that may determine the choice of targeted sectors in a given country in a given year.

Our results can be summarized as follows. First, we find that sectors chosen by IPAs as priority in their investment promotion efforts see an 8 – 10% increase in patent applications or patents granted with at least one domestic inventor, which translates roughly into one additional patent per country-sector-year combination.

Second, we find that investment promotion has a more pronounced impact on innovation in industries that are more R&D intensive. Going from an industry at the 25th percentile of the distribution of R&D intensity to an industry at the 75th percentile increase the impact of investment promotion from about 4% to 13% for patent applications or patents granted. Focusing on an interaction between an industry characteristic and the policy instrument allows for controlling for all unobservables that may determine the decision to grant a priority status to a given sector in a given year in a given country. In this more stringent extended specification, the innovation effects of investment promotion activities are visible only after a few years, which is plausible given that innovation takes time.

Third, an event study analysis provides evidence consistent with parallel trends between targeted and non-targeted sectors. Finally, further robustness checks indicate that our conclusions hold when we consider patents filed at either the US PTO or European or Japanese patent office.

Our findings have policy implications. By decreasing information asymmetries and making it easier and less expensive for multinationals to locate in a country FDI promotion policies can facilitate innovation. One of the advantages of these policies is that they focus on new activities rather than on protecting (possibly unsuccessful) incumbents, thus possibly leading to welfare gains (Harrison and Rodriguez-Clare 2009). And unlike tax holidays and subsidies, investment promotion is an inexpensive policy (Harding and Javorcik 2011).

Our paper contributes to two strands of the existing literature. First, it is related to the literature on the drivers of innovation at the country level. Among those factors are investment in education, R&D outlays and tax policies incentivizing them, intellectual property rights as well as openness to trade (Bøler et al. 2015; Sampson 2015; Edler and Fagerberg 2016; Aghion et al. 2020; Buera and Oberfied 2020; Akcigit et al. 2021; Perla et al. 2021; etc). We contribute to this literature by showing that investment promotion policies can be used as a tool to facilitate innovation.

Second, our study is related to the literature on the impact of FDI on economic growth in host countries. These include a cross-country growth studies by Borensztein et al. (2018) and Alfaro et al. (2004) as well as the literature on productivity spillovers from FDI (Rodriguez-Clare 1996; Javorcik 2004; Javorcik and Spatareanu 2011; Havranek and Irsova 2011, Alfaro and Chen 2018; Alfaro-Urena et al. 2021). We expand on this literature by documenting a positive impact of FDI on innovation.

The paper is structured as follows. Section 2 discusses investment promotion and evidence on its effectiveness. Section 3 describes the data. Section 4 presents the econometric strategy. Section 5 presents the empirical results, and the last section concludes.

2. Investment promotion and FDI inflows

Investment promotion activities aim to facilitate inflows of FDI by lowering the costs of entry and operation in the host country. As defined by Wells and Wint (2000), they include: advertising, investment seminars and missions, participation in trade shows and exhibitions, distribution of literature, one-to-one direct marketing efforts, facilitating visits of prospective investors, matching prospective investors with local partners, help with obtaining permits and approvals, preparing project proposals, conducting feasibility studies and servicing investors whose projects have already become operational. Wells and Wint (2000) exclude from their definition of investment promotion granting incentives to foreign investors, screening potential investment projects and negotiations with foreign investors.

Investment promotion activities can be thought of as falling into four areas: (i) national image building, (ii) investment generation, (iii) investor servicing, and (iv) policy advocacy. Image building activities try to create a perception of the country as an attractive FDI location. Investment generation aims to identify potential investors who may be interested in establishing a presence in the country and to develop a strategy to contact them and start a dialogue with the purpose of having them commit to an investment project. Investor servicing means assisting committed investors in analyzing business opportunities, establishing a business and maintaining it. Policy advocacy comprises initiatives aiming to improve the quality of the investment climate and identifying the views of private sector in this area.

According to investment promotion practitioners, the most effective way of attracting FDI is to focus on a few priority sectors (so called targeting) rather than attempt to attract all types of foreign investors. An agency not engaged in sectoral targeting promotes its country as a good place to do business in general. In contrast, an IPA focusing on priority sectors emphasizes the advantages of locating investment in the target industries. The former IPA will attend many different types of fairs and conferences, while the latter will present only at events specific to the industries it aims to attract. Targeting rests on the idea that a more focused message tailored and delivered to a narrow audience will be more effective than general investment promotion activities.

Recent research convincingly shows that investment promotion is effective in attracting FDI flows (Charlton and Davis 2006; Bobonis and Shatz 2007; Harding and Javorcik 2011; Crescenzi et al. 2021). For instance, Harding and Javorcik (2011), relying on the same World Bank dataset as this study, find that investment promotion leads to higher FDI flows, especially to countries in which red tape and information asymmetries are likely to be severe. Their results suggest that sectors targeted by investment promotion agencies receive on average more than twice as much FDI inflows than non-targeted sectors. A back-of-the-envelope cost-benefit exercise suggests that countries spent on average $90,000 per sector targeted, which brought additional $17 mn of FDI in typical sector, and created 1,159 additional jobs in foreign affiliates.

3. Data

3.1 Investment promotion activities

The data on FDI promotion activities come from the 2005 Census of Investment Promotion Agencies (IPAs) conducted by the World Bank in cooperation with the Foreign Investment Advisory Services, the Multilateral Investment Guarantee Agency and the World Association of Investment Promotion Agencies. This is a unique data set in terms of the extent of its coverage and the level of detail. This survey covers 110 national investment promotion agencies across all geographic regions and country income levels. About three quarters are in developing countries. Importantly for the purposes of our study, the Census includes time-varying information on the sectors that were targeted by IPAs in their investment promotion efforts.[8]

Of 110 countries that responded to the survey, 86 declared their investment promotion efforts focus on a selection of priority (targeted) sectors. Of those, 66 countries provided complete information on which sectors they target and the timing of their targeting efforts. The information allows us to

[8] This particular dimension of the data has been explored by Javorcik and Harding (2011 and 2012) who studied the impact of investment promotion on FDI inflows and upgrading of export quality, respectively.

create an FDI sector targeting variable that is time varying and captures the sector and the years when a country targeted FDI. The FDI sector targeting dummy varies by 2-digit sector codes.[9] Investment promotion data are available over the period 1980-2004. Regressions specifications with five-year lags of the targeting variable allow us to investigate the policy impact up to 2010. In our sample, we include countries that provided complete information as well as countries not engaged in sector targeting.

Most frequently targeted industries are: Computer, Electronic and Optical Products (NACE 26), Fabricated Metal Products (NACE 25), Chemical and Chemical Products (NACE 20), Electrical Equipment (NACE 27), Machinery and Equipment (NACE 28), followed by Manufacture of Food (NACE 10) (see Figure A1 in the online Appendix).

3.2 Patent data

To capture innovation we use comprehensive patent data for 1980-2010 from the PATSTAT (Autumn 2019 version) compiled by the European Patent Office.[10] PATSTAT contains comprehensive information on all patent applications and all patents granted at every patent office in the world. As stringency of requirements may vary across national patent offices, in our baseline analysis we focus on patent applications filed at the US Patent Office (US PTO). In an extension, we consider applications filed in at least one of the three main patent offices, namely the US PTO, European PTO and Japanese PTO. We consider general patents, utility patents and design patents but exclude so called artificial patents.[11]

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[9] Census respondents were given a list of industries in the questionnaire but had also an opportunity to write in the names of industries relevant to them.

[10] PATSTAT has been used extensively in academic research, including a recent paper by Aghion et al. (2020).

[11] The PATSTAT downloads comprise general patents, utility patents, and design patents. According to PATSTAT,"**Utility Patents** are applicable to the invention, discovery, or improvement of any useful process, machine, article of manufacture, or composition of matter. For example, a utility patent would be used to protect a new process of making a computer (process), a new type of computer (machine), a computer part (article of manufacture), or a new chemical (composition of matter). **Design Patents** are applicable to the invention of a new, original, and ornamental design for an article of manufacture. For example, a design patent would be used to protect visual characteristics or aspects of a computer (assuming that it is new and unique). Design patents only protect the appearance of an item, but not an item's structural or functional features."

We focus on patent families, defined as the set of patents granted (or patent applications filed) in several countries which are related to each other by one or several common priority filings. In other words, a patent family captures the same invention disclosed by a common inventor(s) and patented in more than one country.[12] Considering patent families (rather than individual patents) allows us to more accurately capture the timing of innovation. For instance, if a patent is first filed in the European PTO in year 1995 and only one year later in the US PTO, we will consider year 1995 as the time of innovation taking place.[13]

When registered, each patent is associated with one or more technological classes using the International Patent Classification (IPC) system, which classifies patents by products.[14] The recent versions of PATSTAT offer an industry classification (NACE revision 2) for each patent, based on a concordance table between technological classes and NACE codes, provided by Eurostat in co-operation with KU Leuven / Belgium.[15]

The patent data vary by country, 3-digit NACE industry and year. In our baseline analysis, we focus on three proxies for innovation: (i) number of patent family applications relevant to industry *i* filed at the US PTO in year *t* with at least one inventor from country *c*; (ii) number of patent family applications relevant to industry *i* filed at the US PTO by entities from country *c* in year *t* with at least one inventor from country *c*; (iii) number of patent families relevant to industry *i* granted by the US PTO to entities from country *c* in year *t* with at least one inventor from country *c*. The first variable captures innovation developed (or co-developed) by inventor(s) from country *c*, for which a patent application was filed at the US PTO. The second variable restricts attention to patent filings done by entities from country *c*, e.g., domestic firms, subsidiaries of MNCs,

[12] Organisation for Economic Co-operation and Development, Economic Analysis and Statistics Division, *OECD science, technology and industry scoreboard: towards a knowledge-based economy*, OECD Publishing, 2001, ISBN 92-64-18648-4, ISBN 978-92-64-18648-4, page 60.
"Beyond patent families – an updated perspective" *(PDF)*. Patent Information News. European Patent Office (1): 4–5. March 2014.
https://en.wikipedia.org/wiki/Patent_family
[13] This issue arises only in the case of patent applications filed in multiple offices. Our results are robust to focusing on individual patents instead of patent families.
[14] See WIPO, Guide to the International Patent Classification (Version 2019), https://www.wipo.int/export/sites/www/classifications/ipc/en/guide/guide_ipc.pdf
[15] Bart Van Looy, Caro Vereyen and Ulrich Schmoch, Patent Statistics: Concordance IPC V8 – NACE REV.2, Report, Eurostat, October 2014, https://circabc.europa.eu/sd/a/d1475596-1568-408a-9191-426629047e31/2014-10-16-Final%20IPC_NACE2_2014.pdf

research institutes, or individuals, etc. The third variable considers patents awarded while keeping restriction on the innovation being developed (or co-developed) in country c and awarded to an entity from country c.

As some innovations may be protected by patents awarded by offices other than the US PTO, in an extension we consider patent applications filed at at least one of the three major patent offices (US PTO, European PTO or Japanese PTO). As above, we focus on innovations developed (or co-developed) by inventor(s) from country c and applications filed by entities from country c (or patents granted to entities from country c).

3.2 Merged data

The patent data are merged with investment promotion data by country, sector and year. We consider the period 1980-2010. The IPA Census includes 110 countries, of which 56 innovate, i.e., report patents. We exclude countries that report FDI targeting but fail to provide complete information. This leaves us with the final sample of 90 countries, 53 of which engage in sector targeting. Thirty countries are both engaged in targeting and innovate. See Appendix 1 for a list of countries that are included in the baseline regressions, including the list of countries that do FDI sector targeting and those that innovate.

In the analysis, we use the number of patent families as our dependent variable. One of the characteristics of the patent data is the large number of zeros, as not every sector in every country sees patenting activity. There address this issue, we use the inverse hyperbolic sine transformation of the number of patents (following, for instance, Andersson et al. (2015), Coelli (2018)). The inverse hyperbolic sine transformation is defined as:

$$\log(y + (y^2+1)^{1/2})$$

The inverse sine is approximately equal to log(2y) or log(2)+log(y), therefore it can be interpreted in the same way as a standard logarithmic dependent variable, except for very small values of y. This transformation has the advantage that unlike the log variable, the inverse hyperbolic sine is defined at zero.

We augment our data set with information on *R&D intensity* (defined as R&D expenditure to sales ratio) which a 3-digit NACE industry specific variable obtained from the Federal Trade Commission Line of Business survey.

4. Econometric Strategy

Our identification strategy relies on the fact that most countries focus their investment promotion efforts on a selected group of priority sectors rather than an across the board campaign. Therefore, in our empirical analysis we use difference-in-differences to examine whether sectors targeted by investment promotion agencies patent more in the post-targeting period, relative to the pre-targeting period and non-targeted sectors. We estimate the following empirical model:

$$Patents_{cit} = \beta\ Targeted_{cst-k} + \gamma_{cs} + \gamma_{ct} + \gamma_{st} + \varepsilon_{cst}$$

where s = 2-digit NACE sector code; i = 3-digit NACE industry code, t = year, and k ={1,2,3,4,5}. The dependent variable is the inverse hyperbolic sine transformation of the number of patent families applied or the number of granted patent families in country *c's* 3-digit industry i in year t. $Targeted_{cst-k}$ is an indicator variable that equals one if country c targets sector s in its investment promotion efforts at time t, and zero otherwise. We estimate specifications with various lags of this variable to account for the fact that it may take some time for FDI to materialize and affect innovation in host countries.[16] γ_{cs}, γ_{ct} and γ_{st} are country-sector, country-year and sector-year fixed effects, respectively. Time-invariant characteristics that differentiate sectors chosen for targeting from other sectors will be captured by country-sector fixed effects (so there is no need to include a dummy for targeted sectors). Shocks common to all sectors in a country in a particular year will be captured by country-year fixed effects (so there is no need to include a dummy for the post-targeting period). Shocks affecting innovation in a particular sector will be controlled for by sector-year fixed effects. The model is estimated on a sample of countries that have or have not practiced sector targeting. The standard errors are clustered at country-sector level.

[16] Harding and Javorcik (2011) find that FDI inflows respond to investment promotion efforts already in the year after targeting begins.

The main threat to identification is the potential endogeneity of sector targeting. It could be that that countries choose to target sectors that have already experienced innovation or are likely to do so in the future. We address this concern by asking a more nuanced question: is the impact of investment promotion larger in R&D-intensive industries? We would expect this to be the case, given that multinational firms account for majority of the world's R&D expenditure. Focusing on an interaction allows us to control for a country-sector-year fixed effect (γ_{cst}) that will absorb all the unobservables that may determine the choice of targeted sectors in a given year. This amended specification takes the following form:

$$Patents_{cit} = \theta\ Targeted_{cst-k} * R\&D\ intensity_i + \alpha_{cst} + \alpha_{it} + \varepsilon_{cit}$$

where the dependent variable $Targeted_{cst-k}$ is defined as before. $R\&D\ intensity_i$ is a variable capturing various features of a particular *3*-digit industry *i* (which is defined at a more disaggregated level than a *2*-digit sector *s*). Note that inclusion of country-sector-year fixed effects (α_{cst}) means that we do not need to include $Targeted_{cst-k}$ in the specification. Inclusion of industry-year fixed effects (γ_{it}) means that we do not need to include $R\&D\ intensity_i$ in the model. These latter fixed effects capture all shocks affecting innovation in a particular industry in a particular year. As before, standard errors are clustered at the country-sector level.

The summary statistics of the main variables are presented in Table A2 in the online Appendix.

5. Results

5.1 Baseline analysis

We start our analysis by focusing on the number of patent family applications filed in the US PTO for innovations involving at least one inventor from the country engaged in investment promotion.[17] We estimate five specification, each allowing for an increasingly longer lag between a sector being targeted by investment promotion efforts and patent applications being filed.[18] The estimation results, presented in the top panel of Table 1, lend support to our hypothesis. They

[17] In all results that follow we consider patent families. However, to avoid cumbersome language we will speak of patents rather than patent families going forward.

[18] Our targeting data stop in 2004, hence focusing on longer lags allows us to include patenting data for the post-2004 period and have more observations.

suggest that investment promotion efforts are associated with an increase in innovation in the targeted sector. The coefficient on the *Targeted* dummy is positive and statistically significant at the one percent level in all specifications with its magnitude ranging from 0.0928 to 0.0990. The magnitude of the estimated effect is economically meaningful. Sectors targeted by investment promotion efforts see an almost 10% increase in the number of patent applications in the post-targeting period (see column 4), which corresponds to an additional 1.3 patent applications per country–sector–year combination. To put this figure into perspective, it is worth noting that the average number of patent applications in our dataset is zero and that the country-sector-year observation at the 90th percentile corresponds to 4 patent applications.

In the middle panel of Table 1, we impose an additional requirement that the application must be filed by an entity from country c. In other words, we exclude a situation where, for instance, an innovation is developed (or co-developed) in a subsidiary of a multinational, but the patent is filed by the multinational's headquarters (or another subsidiary). The estimated coefficients remain positive and statistically significant at the one percent level in all specifications, but their magnitude declines slightly to 0.0809 – 0.0976, which corresponds to 1.06 additional patent applications being filed.

The bottom panel considers patents granted by the US PTO for innovations developed with participation of a least one inventor from the country undertaking FDI promotion efforts and awarded to an entity in this country. Again, we find support for our hypothesis. All estimates are positive and statistically significant at the one percent level. As expected, they are somewhat smaller in magnitude particularly when the shorter lags are considered, ranging from 0.0788 to 0.0945. The estimates correspond to investment promotion efforts being associated with between 0.78 and 0.94 additional patents granted.

5.2 Expanded specification – Controlling for unobservables at the country-sector-year level

The main threat to identification lies in non-random selection of priority sectors by investment promotion agencies. To deal with this issue we focus on a more nuanced question: *is the link* *between investment promotion and patenting stronger in industries where we would expect it to be stronger?*[19]

Our conjecture that the impact of FDI is likely to be more visible in R&D intensive industries is based on several observations. First, multinationals are more likely to be active in these industries. Second, multinationals tend to undertake large R&D outlays, so they are likely to enjoy a greater advantage over indigenous firms in such industries. Multinationals may also need to adapt their numerous products to local markets, resulting in disproportionately more innovation in R&D-intensive industries in host countries.

Focusing on interaction term between industry R&D intensity and the indicator for targeted sectors allows us to control for country-sector-year fixed effects that *will capture all of unobservables that determine the choice of priority sectors in a given country in a given year*.

The results from the expanded specification are presented in Table 2, which mirrors the layout of Table 1. Overall, the results are in line with our hypothesis, even if they are less precisely estimated. The results suggest that investment promotion activities are more strongly related to innovation in R&D intensive industries, *even controlling for country-sector-year* fixed effects.

The top panel focuses on the number patent applications where at least one inventor from country *c* was involved. All estimated coefficients are positive, though only those on the longest three lags (*t-3*, *t-4*, *t-5*) reach conventional levels of statistical significance. The estimated magnitudes are economically meaningful. Going from an industry at the 25th percentile of the distribution of R&D intensity to an industry at the 75th percentile increases the impact of investment promotion on innovation from 5.6% to 19.3% and thus is associated with 1.8 additional patent applications (based on the results from columns 5).

The results in the middle panel of Table 2 consider patent applications for innovations with at least one domestic inventor filed by an entity from the same country. We confirm the pattern found in the top panel: FDI promotion efforts are associated with more innovation in R&D-intensive

[19] Recall that sectors pertain to a higher aggregation level than industries (2 digit NACE vs 3 digit NACE).

industries. The estimated coefficients are positive and statistically significant for longer lags, i.e., in columns (3) through (5). An increase in R&D intensity from the 25th to the 75th percentile is associated with the impact of investment promotion on patent applications increasing from 4.9% to 17.2% and thus resulting in 1.3 additional patent applications.

The bottom panel considers patents granted. As before, the coefficients on the interaction terms are positive and statistically significant in the last three specifications with magnitudes very similar to those observed earlier. Moving from an industry at the 25th percentile of R&D-intensity to one at the 75th percentile increases the impact of investment promotion efforts on innovation from 5.1% to 17.8% and translates into 1.5 additional patents being granted.

5.3 Testing for pre-trends

One important question is whether the targeted and non-targeted sectors exhibited the same trends in innovation prior to policy interventions. To shed light on this issue, we conduct an event study focusing on the three years before and four years after FDI targeting policy begins, with the year prior to the policy change (*t-1*) being the omitted category. The results are depicted in Figure 1, which includes three graphs, one for each outcome variable considered in our analysis.

The patterns depicted in all three graphs support the parallel trends assumption, which is reassuring for our identification strategy. Moreover, the graphs show that the effect of investment promotion kicks in with a delay, which is to be expected given that innovation takes time. The delayed effect is also consistent with the conclusions emerging from our stringent extended specification, which accounts for unobservable heterogeneity at the country-sector-year level.

5.4 Extension to other major patent offices

One may be concerned that inventors from some countries may be more inclined to file patent applications in the European or the Japanese patent office instead of the US PTO. To take this possibility into account, we conduct a robustness check by focusing on patents involving at least one inventor from country *c* and filed by an entity from country *c* in any of the three patent offices mentioned. As before, we consider both patent applications and patents granted.

The results from a baseline specification, presented in Table 3, confirm our earlier findings. Whether we consider patent applications or patents granted, the estimated coefficients of interest are positive and statistically significant at the one percent level in all specifications. Their magnitudes are only slightly smaller than those found before.

The results are also robust when we consider the extended specification in Table 4. The magnitude of the estimated coefficients increases with the length of the lag, and only the estimates for the longer lags reach conventional statistical significance levels. The magnitudes are in line with those obtained in Table 2.

6. Conclusions

This study investigates a crucial, yet previously overlooked, effect of investment promotion activities, which is its impact on host country's innovation. Multinationals are creators of knowledge and innovation leaders, and attracting them to a host country can lead to an increase in R&D activities directly sponsored by multinationals as well as knowledge spillovers, thus potentially increasing the innovation capacity of the host country.

We use detailed data on national FDI promotion efforts together with comprehensive data on patent applications and patents granted to test whether sectors explicitly targeted by investment promotion agencies in their efforts to attract FDI innovate more in the post-targeting period, relative to the pre-targeting period and non-targeted sectors. In our extended specification, we focus on an interaction between industry R&D intensity and sector targeting, which allows us to control for country-sector-year fixed effects and thus absorb all unobservables that may determine the choice of targeted sectors in a given year in a given country. We find that investment promotion leads to more patent applications and patents granted for innovations involving an inventor from the country engaged in investment promotion, especially in industries with greater R&D intensity.

Our findings suggest that investment promotion can be an effective and inexpensive tool for countries to increase their innovation capacity by attracting foreign investors. The results are especially important for policymakers who want to harness FDI to stimulate innovation and long-term economic growth.

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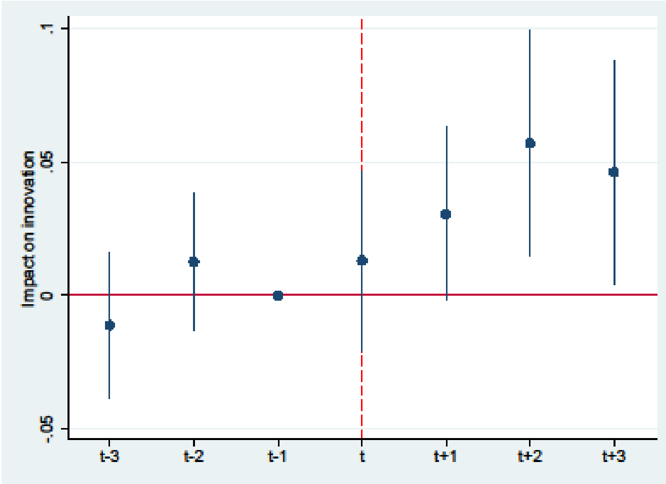
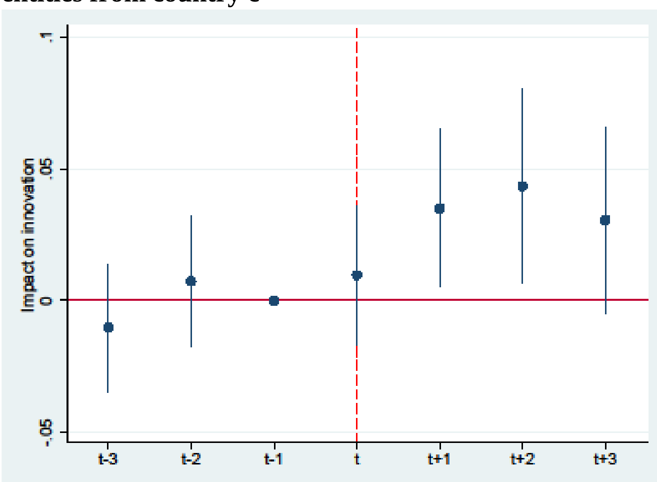
Figure 1. Event studies

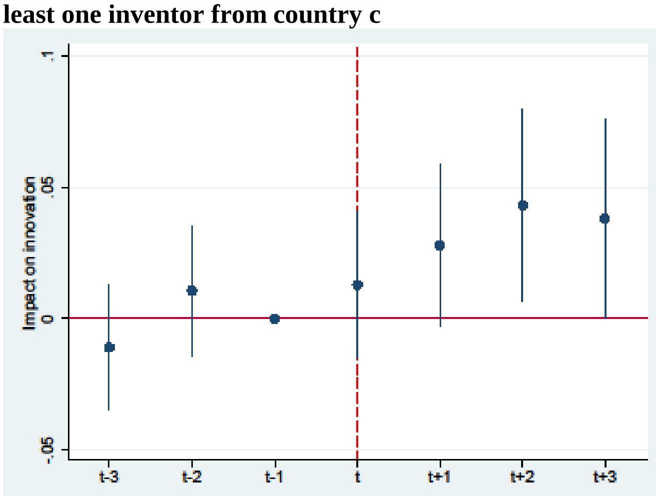
Panel A: No. of patent family applications at the US PTO with at least one inventor from country c



Panel B: No. of patent family applications at the US PTO with at least one inventor from country c filed by entities from country c



Panel C: No of patent families granted by the US PTO to entities from country c for inventions involving at least one inventor from country c



Notes: All the graphs depict 90 percent confidence intervals.

Table 1. Patent applications and patents granted at the US PTO

	No of patent family applications at the US PTO with at least one inventor from country c				
$Targeted_{t-1}$	**0.0938*****				
	[0.0239]				
$Targeted_{t-2}$		**0.0928*****			
		[0.0229]			
$Targeted_{t-3}$			**0.0995*****		
			[0.0240]		
$Targeted_{t-4}$				**0.0990*****	
				[0.0241]	
$Targeted_{t-5}$					**0.0927*****
					[0.0240]
Observations	109,144	110,282	111,427	112,569	112,572
R-squared	0.824	0.825	0.825	0.825	0.825
	No of patent family applications at the US PTO with at least one inventor from country c filed by entities from country c				
$Targeted_{t-1}$	**0.0809*****				
	[0.0251]				
$Targeted_{t-2}$		**0.0837*****			
		[0.0250]			
$Targeted_{t-3}$			**0.0945*****		
			[0.0275]		
$Targeted_{t-4}$				**0.0976*****	
				[0.0267]	
$Targeted_{t-5}$					**0.0940*****
					[0.0256]
Observations	109,144	110,282	111,427	112,569	112,572
R-squared	0.819	0.819	0.82	0.82	0.821
	No of patent families granted by the US PTO to entities from country c for inventions involving at least one inventor from country c				
$Targeted_{t-1}$	**0.0788*****				
	[0.0250]				
$Targeted_{t-2}$		**0.0828*****			
		[0.0253]			
$Targeted_{t-3}$			**0.0909*****		
			[0.0278]		
$Targeted_{t-4}$				**0.0945*****	
				[0.0272]	
$Targeted_{t-5}$					**0.0897*****
					[0.0259]
Observations	109,144	110,282	111,427	112,569	112,572
R-squared	0.818	0.817	0.817	0.816	0.817

***, **, * denote significance at the 1, 5 and 10% level, respectively. The dependent variable is the inverse hyperbolic sine transformation of the number of patent applications or grants. Standard errors have been clustered at the country-sector level.

Table 2. Patent applications and patents granted at the US PTO: Interactions with R&D intensity

	No of patent family applications at the US PTO with at least one inventor from country c				
Targeted$_{t-1}$*R&D intensity	4.077				
	[3.164]				
Targeted$_{t-2}$*R&D intensity		4.659			
		[3.124]			
Targeted$_{t-3}$*R&D intensity			**5.722***		
			[3.151]		
Targeted$_{t-4}$*R&D intensity				**5.619***	
				[3.258]	
Targeted$_{t-5}$*R&D intensity					**6.312***
					[3.629]
Observations	100,061	101,114	102,180	103,226	103,235
R-squared	0.874	0.875	0.876	0.877	0.878
	No of patent family applications at the US PTO by entities from country c with at least one inventor from country c				
Targeted$_{t-1}$*R&D intensity	3.747				
	[2.832]				
Targeted$_{t-2}$*R&D intensity		4.292			
		[2.855]			
Targeted$_{t-3}$*R&D intensity			**5.262***		
			[2.923]		
Targeted$_{t-4}$*R&D intensity				**5.172***	
				[3.079]	
Targeted$_{t-5}$*R&D intensity					**5.632***
					[3.414]
Observations	100,061	101,114	102,180	103,226	103,235
R-squared	0.866	0.867	0.869	0.87	0.872
	No of patent families granted by the US PTO to entities from country c for inventions involving at least one inventor from country c				
Targeted$_{t-1}$*R&D intensity	3.893				
	[2.796]				
Targeted$_{t-2}$*R&D intensity		4.464			
		[2.827]			
Targeted$_{t-3}$*R&D intensity			**5.383***		
			[2.890]		
Targeted$_{t-4}$*R&D intensity				**5.404***	
				[3.044]	
Targeted$_{t-5}$*R&D intensity					**5.832***
					[3.369]
Observations	100,061	101,114	102,180	103,226	103,235
R-squared	0.864	0.865	0.866	0.867	0.867

***, **, * denote significance at the 1, 5 and 10% level, respectively. The dependent variable is the inverse hyperbolic sine transformation of the number of patent applications or grants. Standard errors have been clustered at the country-sector level.

Table 3. Patent applications and patents granted at the US PTO, European PTO or Japanese PTO

	No of patent family applications filed at US PTO, European PTO or Japanese PTO by entities from country c involving at least one inventor from country c				
$Targeted_{t-1}$	**0.0718*** **				
	[0.0206]				
$Targeted_{t-2}$		**0.0724*** **			
		[0.0202]			
$Targeted_{t-3}$			**0.0814*** **		
			[0.0221]		
$Targeted_{t-4}$				**0.0848*** **	
				[0.0225]	
$Targeted_{t-5}$					**0.0752*** **
					[0.0222]
Observations	109,144	110,282	111,427	112,569	112,572
R-squared	0.837	0.837	0.837	0.837	0.838
	No of patent families granted by US PTO, European PTO or Japanese PTO to entities from country c involving at least one inventor from country c				
$Targeted_{t-1}$	**0.0706*** **				
	[0.0203]				
$Targeted_{t-2}$		**0.0721*** **			
		[0.0201]			
$Targeted_{t-3}$			**0.0818*** **		
			[0.0220]		
$Targeted_{t-4}$				**0.0838*** **	
				[0.0226]	
$Targeted_{t-5}$					**0.0774*** **
					[0.0225]
Observations	109,144	110,282	111,427	112,569	112,572
R-squared	0.83	0.83	0.83	0.83	0.83

***, **, * denote significance at the 1, 5 and 10% level, respectively. The dependent variable is the inverse hyperbolic sine transformation of the number of patent applications or grants. Standard errors have been clustered at the country-sector level.

Table 4. Patent applications and patents granted by the US PTO, European PTO or Japanese PTO: Interactions with R&D intensity

	No of patent family applications filed at US PTO, European PTO or Japanese PTO by entities from country c involving at least one inventor from country c				
$Targeted_{t-1}$*R&D intensity	3.794				
	[2.937]				
$Targeted_{t-2}$*R&D intensity		4.381			
		[2.930]			
$Targeted_{t-3}$*R&D intensity			**5.276***		
			[3.002]		
$Targeted_{t-4}$*R&D intensity				**5.205***	
				[3.122]	
$Targeted_{t-5}$*R&D intensity					5.293
					[3.417]
Observations	100,061	101,114	102,180	103,226	103,235
R-squared	0.88	0.881	0.883	0.884	0.885

	No of patent families granted by US PTO, European PTO or Japanese PTO to entities from country c involving at least one inventor from country c				
$Targeted_{t-1}$*R&D intensity	3.912				
	[2.810]				
$Targeted_{t-2}$*R&D intensity		4.393			
		[2.819]			
$Targeted_{t-3}$*R&D intensity			**5.349***		
			[2.891]		
$Targeted_{t-4}$*R&D intensity				**5.333***	
				[3.032]	
$Targeted_{t-5}$*R&D intensity					**5.581***
					[3.332]
Observations	100,061	101,114	102,180	103,226	103,235
R-squared	0.874	0.874	0.875	0.876	0.877

***, **, * denote significance at the 1, 5 and 10% level, respectively. The dependent variable is the inverse hyperbolic sine transformation of the number of patent applications or grants. Standard errors have been clustered at the country-sector level.

ON-LINE APPENDIX (NOT FOR PUBLICATION)

Figure 1. Frequency of sectors targeting by 2-digit NACE industry

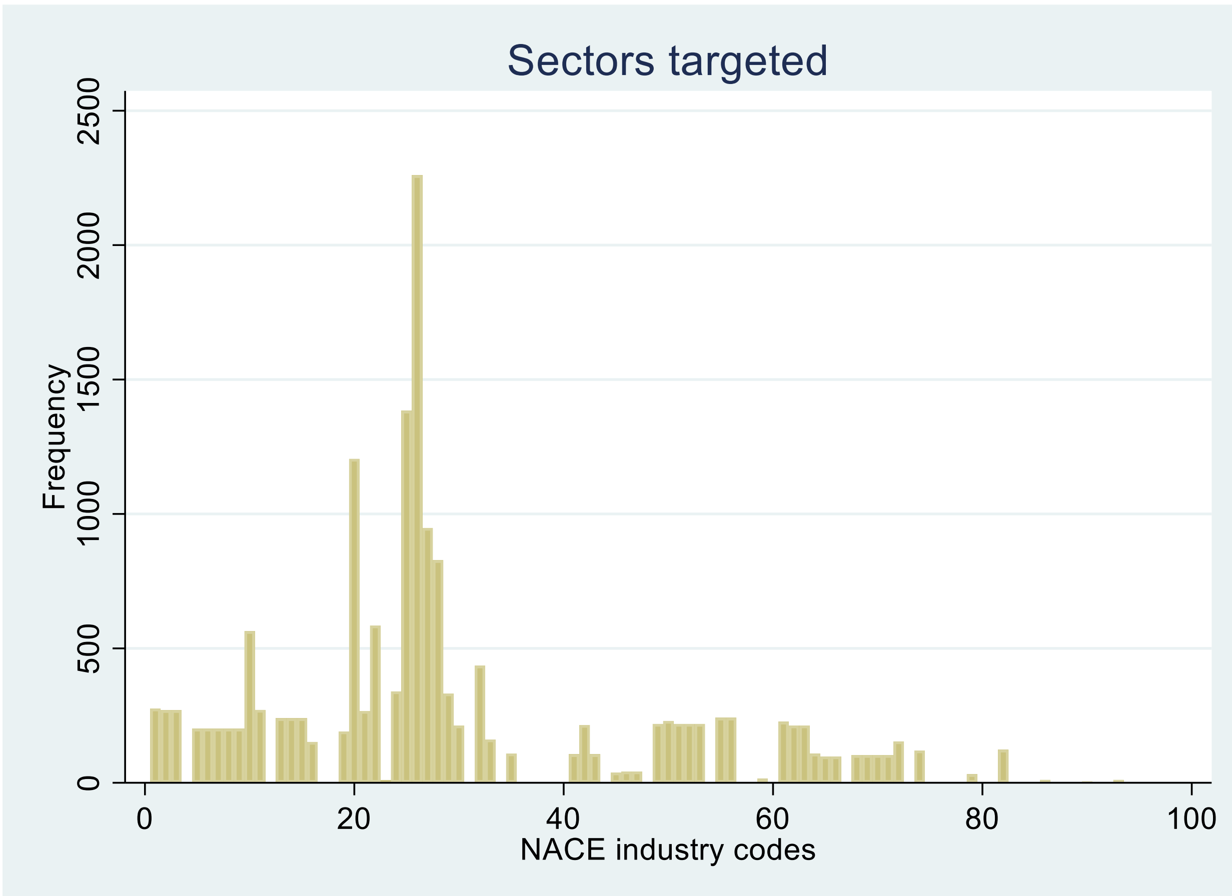


Table A1. List of countries considered

All countries in basic regression sample	Countries that do targeting	Countries that do targeting and innovate
Albania	Albania	
Algeria		
Argentina		
Armenia	Armenia	Armenia
Aruba	Aruba	
Australia	Australia	Australia
Austria	Austria	Austria
Belize		
Bosnia and Herzegovina	Bosnia and Herzegovina	
Botswana	Botswana	
Brazil		
Bulgaria	Bulgaria	Bulgaria
Cambodia	Cambodia	Cambodia
Canada	Canada	Canada
Cape Verde		
Cayman Islands		
Chile	Chile	Chile
China		
Congo, Dem. Rep.	Congo, Dem. Rep.	
Costa Rica	Costa Rica	Costa Rica
Cyprus	Cyprus	Cyprus
Czech Republic	Czech Republic	Czech Republic
Cote d'Ivoire	Cote d'Ivoire	
Ecuador	Ecuador	
Egypt, Arab Rep.		
El Salvador	El Salvador	
Fiji	Fiji	
Finland	Finland	Finland
France	France	France
French Polynesia	French Polynesia	
Gambia, The		
Georgia		
Ghana	Ghana	Ghana
Greece	Greece	Greece
Guatemala	Guatemala	
Guinea	Guinea	
Hungary	Hungary	Hungary
Iceland	Iceland	Iceland
Iran, Islamic Rep.		
Italy		
Jamaica		
Japan		
Jordan	Jordan	Jordan
Kazakhstan	Kazakhstan	Kazakhstan
Kenya		
Korea, Rep.		
Lao PDR		
Latvia		
Lebanon	Lebanon	Lebanon
Lithuania	Lithuania	Lithuania
Macedonia, FYR		
Madagascar		
Malta		
Mauritania	Mauritania	
Mauritius	Mauritius	
Mexico		

Mongolia	Mongolia	Mongolia
Mozambique	Mozambique	
Netherlands	Netherlands	Netherlands
Netherlands Antilles	Netherlands Antilles	
New Zealand	New Zealand	New Zealand
Nicaragua	Nicaragua	
Oman	Oman	
Pakistan	Pakistan	Pakistan
Palau		
Panama		
Paraguay		
Peru	Peru	
Portugal		
Qatar		
Romania		
Samoa	Samoa	
Saudi Arabia		
Senegal	Senegal	Senegal
Singapore		
Slovak Republic		
Slovenia	Slovenia	Slovenia
South Africa	South Africa	South Africa
Spain		
St Vincent and the Grenadines		
Sweden	Sweden	Sweden
Switzerland		
Syran Arab Republic		
Tunisia	Tunisia	Tunisia
Turkey		
Uganda	Uganda	
Uruguay		
Vanuatu	Vanuatu	
Venezuela, RB	Venezuela, RB	Venezuela
Zambia		

Table A2. Summary statistics

	Obs	Mean	Std. Dev.	Min	Max
Patents filed at US PTO with at least one inventor from country c					
No. patent family applications	112,572	13.299	168.624	0	8,702
No. granted patent families	112,572	10.811	134.175	0	6,234
Hyperbolic Sine no. patent family applications	112,572	0.524	1.310	0	9.764
Hyperbolic Sine no. granted patent families	112,572	0.483	1.248	0	9.431
Patents filed at US PTO with at least one inventor from country c and applicant from country c					
No. patent family applications	112,572	11.346	152.316	0	7,799
No. granted patent families	112,572	9.979	131.526	0	6,161
Hyperbolic Sine no. patent family applications	112,572	0.450	1.221	0	9.655
Hyperbolic Sine no. granted patent families	112,572	0.429	1.185	0	9.419
Patents filed at US PTO, European PTO or Japanese PTO with at least one inventor from country c and applicant from country c					
No. patent family applications	112,572	14.829	178.263	0	9,113
No. granted patent families	112,572	11.908	144.513	0	6,841
Hyperbolic Sine no. patent family applications	112,572	0.544	1.360	0	10
Hyperbolic Sine no. granted patent families	112,572	0.487	1.277	0	10
Targeted	104,824	0.057	0.231	0	1.000
R&D intensity	103,235	0.021	0.018	0	0.089