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"No man is an island"
Inward FDI and Local Innovative Performance

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Abstract
Do knowledge externalities from FDI foster local innovative performance in recipient economies? Employing manufacturing data for the period 2001-2006, this paper examines whether foreign investment yields benefits to innovation activities in Italian provinces. Our empirical exercise aims at contributing to the existing debate on the impact of FDI in two main respects. Firstly, we attempt to tackle measurement issues that affect most existing studies by employing direct indicators for both FDI and innovation. Secondly, we try to recover reliable causal predictions and to address consistently the endogeneity of the regressor of interest by adopting a novel identification strategy based on an instrumental variable approach. This is rarely practiced in the relevant literature, mainly due to problems associated with individuating an exogenous instrument for FDI. We trace strong positive effects of FDI on local innovative performance, confirming a substantial downward bias in baseline estimates. Our strategy is robust to a number of checks. Isolating a reliable causal relationship is not only relevant for research, but it is also important for public decision-making, considering that the attraction of FDI is often placed at the core of the policy agenda in most countries, especially in time of economic crisis.

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Introduction

In the current wave of globalisation of the world economy, foreign direct investment (FDI) is thought to play a primary role (WTO, 1996; Dicken, 2007). UNCTAD (2012) shows that the volume of FDI has dramatically risen in the last twenty years, with an increase in world FDI inward stock of about 2 millions of dollars to more than 20 million. Policy makers place great emphasis on the potential benefits that may stem from the attraction of FDI. The view that attracting foreign subsidiaries of multinational enterprises (MNEs) will yield great advantages to recipient economies is grounded in the belief that some positive knowledge externalities arise from foreign activities and spread to domestic firms. Beside of several potential benefits, the increase of domestic productivity and the transfer of more advanced technology are frequently considered the main rationale for supporting economic growth through FDI attraction. In this vein, the idea that knowledge plays a fundamental role in the process of growth is deeply rooted in economic theory, which assigns a crucial role to innovation and its diffusion in the economic performance of nations (Grossman and Helpman, 1991).

Nevertheless, it is not entirely clear whether FDI concretely benefit recipient economies. Despite the large amount of studies on this topic and its relevance for public policies, evidence on FDI-induced knowledge externalities remains inconclusive (Rodrik, 1999) with empirical exercises frequently offering mixed suggestions (Smeets, 2008).

By employing Italian manufacturing data to answer the question whether inward FDI benefit the innovative performance of recipient economies, this paper will attempt to add some fresh evidence to the literature on the impact of FDI. There are a number of elements that make this empirical exercise different from the bulk of previous research. Firstly, the impact of knowledge externalities associated to FDI is investigated by employing a direct measure of innovation, namely, patent data. To the best of our knowledge, few papers adopt such an indicator (Cheung and Lin, 2004) while the literature is dominated by studies based on broader measures of economic performance such as total factor productivity (TFP) of domestic firms, labour productivity or growth rate. Secondly, FDI are also measured with a direct indicator. Indeed, while most studies use several indicators of the presence of foreign firms into the host economy, this paper employs the real inflow of foreign capital in Italy. Thirdly, from a methodological

perspective, we attempt to tackle endogeneity biases by means of an Instrumental Variables (IV) approach. While this is a major issue when exploring the impact of FDI given that MNEs' location strategies are very likely to be endogenous to measures of economic performance, very few papers address explicitly the endogeneity issue[2], mainly due to the difficulty to identify an exogenous instrument for FDI. Last but not least, FDI-induced knowledge externalities are underexplored in the case of Italy, with notable exceptions represented by recent contributions by Castellani and Zanfei (2003, 2007). This is instead very interesting for the well-known geographical duality of the Italian economy. Furthermore, the occurrence of knowledge spillovers is investigated along provincial lines (NUTS-3), that is, at a geographical scale that is rarely adopted in the literature mainly due to lack of data. This allows us estimating a more precise effect by reducing the potential ecological fallacy and taking into needed consideration the existence of spatial disparities in both inward FDI and innovation performance.

The paper is organized as follows: the next section reviews the existent literature devoted to the economic rationale of the impact of FDI on innovation. The theoretical background is underpinned by the notion of the superiority of technology possessed by MNEs to justify the existence of positive externalities associated to FDI inflows. Section 3 describes the data while section 4 discusses the main methodological challenges associated to the estimation of the causal effect of FDI on innovation presenting in detail the identification strategy adopted. Section 5 discusses the main results and robustness checks while section 6 concludes.

Conceptual framework

The literature on FDI spillovers implicitly assumes that MNEs have more advanced technology than most domestic firms. Hence, the entry of foreign affiliates into an economy is believed to benefit local firms by providing them with a number of advantages not available domestically, ranging from new technologies to market opportunities. The "superiority" of foreign firms has been firstly theorised within the

[2] One notable example is represented by Haskel et al. (2007).

industrial organisation literature by Hymer (1976/1960)[3]. Domestic firms have general advantages linked to better information about the national market, the language and the legal and political system. Firms wishing to operate in foreign markets need to overcome domestic competition by increasing their efficiency through the acquisition of firm-specific advantages. These include the capacity to access factors of production at lower cost, product differentiation and the availability of more advanced knowledge. This initial evidence was further supported by Dunning (1980) theorising the existence of ownership-specific advantages possessed by some firms that decide to internalise them and to locate in foreign markets as a way to maximize their productive efficiency in a world of imperfect competition and uncertainty. This literature suggests that FDI occurs when firms possess assets of their own and find more profitable to internalise the use of such advantages rather than selling or sub-contracting them to other firms. At the same time, these firms decide to locate in foreign countries where specific location factors allow for a better exploitation of their ownership advantages.

More recently, but in a similar vein, Criscuolo et al. (2010) suggest that MNEs are more productive and innovate more than domestically-oriented firms. Indeed, it is widely acknowledged that MNEs tend to invest large amounts in R&D, generating a notable share of global knowledge (Dicken, 2007; Castellani and Zanfei, 2006; McCann and Acs, 2009).

Given the alleged superiority of technology and assets of MNEs, it is commonly believed that when a foreign subsidiary locates in a new market some knowledge spills over to domestic firms. The idea that FDI may benefit host economies through spillover effects was explored empirically since the 1970s. Early works find a positive relationship between the foreign presence in a host economy and the performance of domestic firms (Caves, 1974, Globerman, 1979, Blomström and Persson, 1983).

Since the 1990s empirical works have increasingly refined along with improvements in the quality of data. In general, recent works try to open what Görg and Strobl (2005) call "the black box" of spillover effects from FDI. In other words, researchers have started to explore both theoretically and empirically a number of specific mechanisms through

[3] Hymer's seminal theory is contained in his 1960 doctoral dissertation which was published posthumously in 1976.

which the presence of foreign activities may benefit domestic firms (Blömstrom and Kokko, 1998; Saggi, 2002; Harris, 2009). Research indicates that the nature of these channels of knowledge transmission is essentially dual for interactions between domestic and foreign firms occur at both intra- and inter-industry level.

Intra-industry (or horizontal) interactions between foreign and domestic firms may lead to knowledge leakages through a variety of mechanisms.

Some scholars suggest that demonstration effects play a great role in knowledge transmission whenever domestic firms are exposed to the superior technology of MNEs subsidiaries (Görg and Greenaway, 2004; Crespo and Fontoura, 2007, Smeets, 2008). More recently, mixed results on the relevance of intra-industry dynamics as "locus" for the transmission of knowledge are presented by Castellani and Zanfei (2003). They use firm-level data for Italy, Spain and France and highlight that positive spillovers only occur in Italy while Spanish and French firms do not experience any productivity gains from the foreign presence. Haskel et al. (2007) investigate intra-industry spillovers from FDI in UK with manufacturing plant-level data and estimate that the foreign presence does benefit domestic firms' productivity. In general, as Görg and Greenaway (2004) stress by comparing forty studies on intra-industry spillovers from FDI, most of which imply demonstration effects, the empirical evidence remains fundamentally weak.

Part of the literature argues that intra-industry spillovers may be denser in more competitive markets. The competitive pressure caused by the entry of foreign firms may act as an incentive for domestic firms to use available resources and existing technology more efficiently (Blomström, 1989; Wang and Blomström, 1992) as well as speeding up the process of adoption of new technologies (Görg and Greenaway, 2004). Also in this case the empirical evidence is rather mixed and still inconclusive with some studies confirming the existence of positive spillovers (Kokko, 1996; Sjöholm, 1997) and others emphasizing the negative externalities associated to the FDI-induced competition that determines a 'market-stealing effect' on domestic firms (Aitken and Harrison, 1999, Crespo et al., 2009).

Finally, intra-industry spillovers have been analysed looking at labour mobility. This literature claims that domestic firms benefit from the transfer of human capital from foreign firms operating in the same industry (Fosfuri, Motta and Rønde, 2001). Since

MNEs are expected to possess a superior knowledge-base, their subsidiaries tend to hire local skilled labour or to train workers. Subsequently, whenever workers move from foreign to domestic firms they carry their acquired knowledge benefitting local businesses. Moreover, spin-off dynamics might emerge when workers leave their jobs in a foreign affiliate to start up their own business (Boschma and Wenting, 2007). A number of studies support this latter view (Görg and Strobl, 2005, Hale and Long, 2006), but also in this case there is weak consensus, with part of the existing literature arguing that MNEs may pay higher wages to prevent trained workers to move to a competitor, thus posing a limitation to labour mobility (Fosfuri, Motta and Rønde, 2001). While reducing knowledge spillovers, these higher wages are believed to lead to pecuniary externalities that increase the host country's welfare. Nevertheless, as a side effect, increasing wages in foreign subsidiaries could adversely impact productivity in domestic firms forasmuch as higher salaries encourage skilled labour to move from domestic to foreign activities (Sinani and Mayer, 2004).

Inter-industry (or vertical) interactions between foreign and domestic firms appear to be more witting than intra-industry dynamics. As a matter of fact, when firms operate in different industrial segments that are vertically connected with each other, they can intentionally establish backward and forward linkages. Although these inter-industry interactions are produced by firms' strategies, knowledge transmission may also occur unintentionally through these vertical channels. From an empirical point of view a number of evidences have been provided in support of the existence of valuable inter-industry spillovers working through backward and forward linkages (Blalock, 2001, Ernst and Kim, 2002, Crespo and Fontoura, 2007, Javorcik, 2004, Javorcik and Spatareanu, 2008, 2009, Bitzer et al., 2008, Blalock and Gertler, 2008, Markusen and Venables, 1999, Castellani and Zanfei, 2006, Crespo and Fontoura, 2007). Knowledge externalities may also be reinforced by the technical support that foreign firms in upstream sectors intentionally provide to local customers with the aim of increasing their demand, as suggested by Marcin (2008). Nevertheless, intermediate goods with higher technological content may imply an increase of prices rather than a reduction leading to negative FDI-induced effects in upstream sectors. This is tested by Javorcik, (2004) on Lithuanian data

and results suggest a non-significant relationship between foreign firms' upstream presence and domestic customers. A negative impact is instead reported by Schoors and Van der Tol (2002) who find that the presence of foreign suppliers adversely affects domestic customers in Hungary. Furthermore, it is plausible that domestically-owned firms do not possess the technological capacity to exploit more sophisticated inputs. Hence, for this reason FDI in upstream industries have no impact on domestic productivity (Bitzer et al., 2008). In this latter case, Javorcik (2004) suggests that the net effect of FDI through forward linkages may be adverse for the potential increase in prices is not offset by a technological gain. In general, while empirical studies seem to confirm that spillovers can pass through backward linkages, in the case forward linkages evidence is rather mixed.

Despite the relevant attention devoted to the issue, recent literature offers rather mixed results with studies often reaching opposite conclusions on both intra-industry and inter-industry spillover mechanisms. Such an empirical inconclusiveness is often invoked by most scholars as the main motivation for further research (Smeets, 2008).

Data

Data used for the analysis is collected from different and complementary sources aggregated at provincial level[4]. Due to the nature of the data and, particularly, to the characteristics of our dependent variable (i.e. patent data) and main regressor of interest (i.e. FDI inflows), the analysis will be restricted to the manufacturing sector. All variables are taken in logarithms and averaged across the period 2001-2006[5].

[4] Note that we consider 103 provinces over the total number of 107 because of lacking data on the 4 more recent Sardinian provinces of Olbia-Tempio, Medio Campidano, Ogliastra and Carbonia Iglesias.

[5] Patent data at the NUTS3 level are in principle available for a longer time series; however data on control variables at the provincial level prior to 2001 are unavailable. Even though still relatively limited, the coverage of a six year period is a significant improvement on the existent quantitative literature on the determinants of innovation in the Italian provinces. All existing studies cover a similar or shorter time span. For example Cainelli et al. (2005) looking at the role of social and institutional factors on the innovative performance of Industrial districts in Emilia Romagna cover the 2002-2007 period; in a similar vein Laursen and Masciarelli (2007), whose analysis is focused on larger geographical units (NUTS2 Regions), still cover a shorter time interval (2001-2003). More specifically related to the impact of FDI on productivity in the Italian case, Castellani and Zanfei (2003) use firm level data for the period 1993-1997 while Castellani and Zanfei (2007) uses a time span 1992-1997.

Innovative performance - The dependent variable is defined as the share of patents per million of inhabitants and it is provided by the OECD REGPAT database containing detailed patent data at NUTS 3 level. Despite some well-known limitations associated with the non-patentability of some inventions, the difficulties in accounting for the differentiated degree of novelty of patented products (not all patented products are equally 'new' and/or valuable) and their potential sectoral bias, patent data remains a reliable measure of innovative output since it provides comparable information on inventions across different regions and a broad range of technological sectors (OECD, 2001; Sedgley and Elmslie, 2004).

FDI Inflows - Data on FDI inflows comes from the Balance of Payment from the Bank of Italy. The database provides detailed data on financial flows by province and sector. This represents a key advantage over the existing literature using indirect proxies for the presence of MNEs (e.g. share of foreign employment, share of foreign enterprises) instead of direct measures of flow.

Innovative Inputs - Controls for the amount of private investments in R&D and graduates in science and technology are provided by ISTAT and are available at regional level (NUTS2).

Additional Regressors - Further controls include the share of value added in manufacturing in each province as proxy for specialization, the share of long term unemployment as proxy for the characteristics of the local labour market, population density as proxy for agglomeration economies and a full set of macro-regional dummies defined at NUTS1 level. All these additional regressors are provided by ISTAT at NUTS 3 level.

The detailed description of variables used in the analysis is reported in Table 1.

Methodology

The estimation of the relationship between FDI and innovation implies a number of methodological issues connected to both the characteristics of the data used for the analysis and the methodological challenges associated to the recoverability of a causal effect.

First of all, it has to be considered that the impact of FDI on local innovation is unlikely to be recoverable on a yearly basis. A certain time lag is reasonably in between the localization of a new business activity and the emergence of a related innovative outcome, both if the impact of FDI passes through an effect due to the innovative activities performed by the new firm and if this impact is instead mediated by an externality mechanism. This concern is exacerbated by the nature of our innovation variable. Despite adopting patent applications[6] as key measure for innovative activities, the granting procedure may require a certain time before being formalized.

Secondly the possibility to exploit the panel dimension is prevented by an additional consideration. Unfortunately, some of our relevant controls, in particular the amount of investments in R&D and the share of graduates, are available only at regional level (NUTS 2). This implies that a certain degree of measurement error is likely to affect our estimation and to lower the credibility of our results. Moreover, due to the limited time dimension of the panel ranging from 2001 to 2006, the within variation in our sample may be insufficient to identify the effect of our regressor of interest (Baltagi, 2005).

Taking into account all these aspects, the analysis of the impact of FDI on local innovation has been carried out adopting a between groups estimation based on an ordinary least squares (OLS) estimation using time averages of the data for the time interval 2001-2006 (group means)[7].

The estimation equation is defined as a place based Knowledge Production Function (KFP) at provincial level, where inward FDI is included as an additional regressor. This

[6] Defined as the OECD as the closest date to the inventive process

[7] As acknowledged by the existing literature the between group estimator is more suitable to address issues related to measurement error as compared to standard panel techniques such as random or fixed effects estimators.

implies that the externalities associated to FDI are modelled in the standard Griliches (1992) framework.

The equation of interest will take the following form:

$$Innovative\ performance_{it} = \beta_0 + \beta_1 K_{it} + \beta_2 L_{it} + \beta_3 FDI\ Inflows_{it} + \beta X + \varepsilon_{it} \quad (1)$$

Where $Innovative\ performance_{it}$ is the share of patents per million of inhabitants in province i at time t, $K_{it}$is the share of private investments in R&D, L_{it} is the share of graduates in science and technology, FDI_{it} is our regressor of interest, namely FDI inflow as share of provincial GDP, X is a vector of provincial controls including the share of value added in manufacturing as proxy for specialization, the long term unemployment share, population density and a full set of macro-regional dummies.

Despite addressing a number of issues, the adoption of a between group estimation amplifies concerns regarding the endogeneity of the regressor of interest. Our key hypothesis is that FDI affect local innovative performance contributing to enrich the local knowledge base and generating positive spillovers through virtuous cycles of cooperation and competition. However, the causal relation between FDI and local innovative performance is not straightforward. A number of time variant and time invariant omitted variables may affect our estimation generating either an upward or downward bias. For example, FDI may be more attracted by areas showing successful innovative performance implying an issue of reverse causality. Firms, as profit maximizing agents, may have an economic incentive to locate in successful areas and to exploit the benefit associated with local favourable conditions. This is a particularly relevant consideration in the case of MNEs aiming to tap into local capabilities and benefit from local competitive advantages implying the risk of overestimating the impact of FDI. On the other side, the effectiveness of new financial investments as carriers of novel information and best practices may be negatively affected by a local environment that is not able to absorb and transform these inputs into innovation. This further implies that in the case of deprived areas or localities characterized by relevant deficits in terms of local absorptive capacities we may underestimate the impact of FDI.

The endogeneity of FDI and the concern associated to the robust identification of its effect on the economic performance of recipient areas is widely acknowledged by the existing literature. Except for early studies using cross-sectional data and suffering from biased estimates due to a number of elements not explicitly accounted for, recent contributions in this field address more carefully the endogeneity issue thanks also to the availability of better data as well as more refined techniques. By comparing a fair number of works, Görg and Greenaway (2004) highlight that the evidence on positive spillovers tends to be weaker when more sophisticated econometric analysis is implemented. These considerations suggest that there are a number of omitted factors affecting early studies' results. While recent works based on panel data are able to eliminate some disturbance due to the time invariant omitted component, they struggle in tackling other sources of bias associated to time variant omitted variables and reverse causality; in fact, variation in FDI could still be endogenous to changes in domestic productivity. For example, in most contributions it is not entirely clear whether FDI determines knowledge externalities that are subsequently captured by domestic firms, or FDI actually goes where domestic firms are more productive and innovative. For instance, while most literature looks for knowledge externalities arising from foreign firms' activities to the advantage of domestic firms, knowledge flows can also run in the opposite direction.

Only few papers go beyond panel data techniques in the attempt to disentangle the true effect of FDI. Some recent contributions exploit GMM techniques to control for the endogeneity of the regressor of interest (Crespo et al., 2009, Driffield, 2006). More notably Haskel et al. (2007) adopts several arrangements for tackling endogeneity: firstly, they employ lagged measures for FDI arguing that knowledge externalities take time to materialize and that previous FDI are uncorrelated with future domestic shocks; secondly, they replace changes in FDI with initial levels; thirdly, and most convincingly, they construct an instrument based on the setting proposed by Allison et al. (2007) instrumenting FDI in UK with FDI in the US. They argue that changes in inward FDI in the UK are correlated with variation in inward FDI in the US since both are driven by world shocks, such as liberalisations, faced by MNEs. Nevertheless, it is worth noting that instrument exogeneity is based on the assumption that international shocks affecting MNEs strategies do not impact UK domestic firms' productivity. In authors words, "this

would assume, for example, that the liberalizations are not driven by technology innovations that are sufficiently global in scope to influence these domestic firms" (p. 489).

To recover predictions about the genuine causality between FDI and local innovative performance we adopt a novel instrumental variable (IV) approach. The cross sectional nature of our estimation prevents us from the possibility to adopt consistently lagged measures of FDI as instrument for the actual flow. Despite reasonably tackling the issues of reverse causality, they may cast some doubts about the correlation with additional time variant and time invariant omitted variables. Therefore, to construct our instrument we build on the "shift-share" methodology associated with Bartik (1991) and recently popularized by a number of contributions in different fields (Card, 2007, Moretti 2010, Overman, Faggio, 2012). This instrument uses initial shares of employment by division[8] in each province and the average amount of FDI inflows at national level between 2001 and 2006 by division to instrument the amount of FDI that each province receives during the same time interval. The rationale behind this instrumental variable builds on the idea that in the absence of area specific shocks, each province would benefit from a share of FDI inflows proportional to its initial share of employment by division taken as a measure of specialization. This further implies assuming that the location decision of MNEs looks at the characteristics of the local production system and tends to be skewed toward areas characterized by a greater potential in terms of backward and forward linkages, complementarities in production, availability of trained labour force and local know how. The instrument is then expected to be significantly and positively correlated with our regressor of interest due to the traditional stability in the sectoral specialization of Italian provinces.

[8] Defined in terms of 2 digits NACE classification coming from the 1991 Census. Note that the 2 digit dimension has been preferred to more detailed classification in order to account for both broader sectoral spillovers.

More specifically it will takes the following form:

$$IV\_FDI_{it} = \sum_j Employment\ share^j_{i,1991} \times (1 + FDIInflows^j_{2001-2006}) \quad (2)$$

where $FDI^j_{2001-2006}$ represents the share of FDI inflows in the 2 digits sector j at national level within the period 2001-2006 and $Employment\ share^j_{i,1991}$ is the share of employment in sector j and province i in 1991. This implies that the flows of FDI at national level by sector are attributed to each province based on the initial degree of sectoral specialization.

Results and Robustness checks

Main results for our specification of interest are reported in Table 2. Column 1 presents our baseline specification where the innovative performance of Italian provinces is regressed on the amount of inputs devoted to the innovation process, namely investment in R&D and share of graduates in science and technology. As expected, the amount of financial investment in R&D strongly predicts local innovative performance while our measure of human capital, despite positively correlated with the dependent variable, remains insignificant.

This evidence correlates with findings in recent studies (Crescenzi et al. 2013) supporting one of the specificities of the Italian case: differently from the rest of Europe or the US (Crescenzi et al. 2007) "the local endowment of human capital does not exert a direct impact on local innovation due to the fundamental mismatch between (Southern) graduates' skill profile and their occupations" (Crescenzi et al. 2013, see also Iammarino and Marinelli, 2011).

Column 3 includes explicitly the regressor of interest, namely the amount of FDI as share of provincial GDP, supporting the existence of a positive and significant correlation at 1% level with the innovative performance of Italian provinces. Further controls are progressively added in the following columns in order to test for the robustness of our correlation against the inclusion of potentially relevant variables. Regressors for population density as proxy of agglomeration, value added in manufacturing as measure

of specialization and long term unemployment to control for local labour market characteristics are explicitly included in columns 3, 4 and 5 respectively. Column 5 also adds a full set of macro-regional dummies to rule out the risk of time invariant fixed effect operating at broader geographical scale. This is a particularly relevant issue in the case of Italy given the traditional north-south divide within the country.

All the regressors show the expected sign with population density significantly and positively correlated to local innovative performance and long term unemployment significantly and negatively associated to innovation. Interestingly, our control for specialization in manufacturing, despite entering our regression as significant and positively related to innovation (Tab.2, Col. 4), becomes insignificant once controls for long term unemployment and macro-regional dummies are included, corroborating our feeling with respect to the role played by the traditional north-south Italian dichotomy. Finally, it is worth noting that the inclusion of additional controls lower the significance of investments in R&D, further supporting the key role of external inputs and the availability of an "enabling environment for innovativeness" (Glaeser et al, 2010) in fostering local innovative performance.

The regressor of interest, the share of inward FDI, despite the slightly decreasing magnitude in the coefficient, remains significant at 1% level and positively correlated to innovation in all specifications.

In spite of the evidence in favour of the existence of a robust correlation between FDI and local innovative performance in the case of Italian provinces, it has to be acknowledged that our specification, focusing only on the inflow of FDI, may underestimate the potential negative effect of foreign disinvestment. The relevance of the latter as key control for the investigation of the impact of FDI inflows in specific geographical contexts has been rarely investigated within the existing literature mainly due to lack of data. Nonetheless, foreign disinvestments may weaken the local production system and reduce the intensity of localized knowledge externalities. This is a particularly relevant concern in the case of Italy where public incentives for the attraction of FDI, especially in southern regions, have been extensively adopted without taking properly into account their long run sustainability. In order to control for this potential negative impact, column

6 includes an additional regressor for foreign disinvestments. As expected, it enters the estimation with a negative sign and, despite being not significant, it contributes to increase the magnitude of our regressor of interest suggesting that disinvestment may have a second order effect in determining the innovative performance of local areas. This evidence is reasonable in the light of our dependent variable measuring innovation rather than productivity or growth. The valuable knowledge externalities arising from FDI are likely to be more relevant in the case of new investment bringing into the local economy novel distinctive technological capabilities. On the other side, disinvestment is reasonably affecting more consistently the strengths of the local production system weakening the intensity of localized agglomeration economies and in its turn the capability to exploit the benefits coming from novel information.

Despite being robust to the inclusion of a number of relevant controls, our estimates are still likely to be affected by the endogeneity of the regressor of interest. As discussed in section 4, this is a key issue in the estimation of the causal effect of FDI and it deserves a more careful investigation. To address the potential bias related to additional omitted variables and reverse causality we adopt the instrumental variable approach previously discussed. Results reported in Column 7 (Table 2) confirm the positive and highly significant correlation (1% level) of inward FDI with our dependent variable. Despite being not evident in terms of changes in the significance level of our regressor of interest, the Hausman test confirms the existence of a substantial bias in our OLS estimates that justifies the change in the magnitude of our coefficient. A change of 1% in the share of FDI on provincial GDP generates a 24% increase in the share of patents application per million of inhabitants. In the interpretation of this value it has to be bear in mind both the scale of our dependent and independent variables[9] and the nature of our measure of innovation, namely patent applications, that are likely to be more representative of the innovative performance of large enterprises rather than small and medium firm. Although few papers investigate the impact of FDI in the Italian case, the evidence in favour of a positive effect of FDI correlates with some recent evidences (Castellani and Zanfei, 2003,

[9] Note that in respect to the existing literature our FDI variable reflects the real amount of capital inflows. An average increase of 1% in the share of FDI over GDP is quantifiable in more than 1 million of Euros while an increase of 24% in the average share of patents per million of inhabitants is about 10 patents.

2007). Despite that, any comparison on the magnitude of the effect remains controversial due to a substantial difference in the actual variables employed. Most of the existing studies adopting proxy measures for both FDI and local innovative performance tend to overlook any further discussion about the actual size of the economic effect.

The first stage estimate reported in Table 3 confirms the reliability of our instrument that is significantly correlated with the instrumented variable. In addition to that and in compliance with the econometric literature on weak instruments (Staiger and Stock, 1997; Stock and Yogo, 2005), the F-statistic for the first stage is reported in Table 4 showing a value that is generally above both the value of 10 reported by Staiger and Stock (1997) and the thresholds values defined by Stock and Yogo (2005).

As additional robustness checks on the goodness of the instrumental variable approach, Table 5 reports our 2SLS estimation progressively eliminating all the controls. The sign and significance level of our regressor of interest remains unchanged confirming that its effect on the innovative performance of Italian provinces is not driven by model specification. This test may also be taken as indirect evidence supporting the validity of the exclusion restrictions.

Finally, in order to provide further support to the instrumental variable approach, the reduced form equation is estimated by means of OLS regression of our dependent variable on the instrument and exogenous controls (Table 6). As shown by Angrist and Krueger (2001), although being poorly informative with respect to the real magnitude of the coefficient, the reduced form can be used as additional test to determine the sign of the coefficient of interest. The estimation of the reduced form equation confirms that FDI Inflows are a positive and relevant determinant of innovation in Italian provinces.

The estimation performed demonstrates to be robust to the inclusion of additional significant regressors and to the correction of the potential bias associated with the endogeneity of the regressor of interest. The instrumental variable approach discussed has showed to be strongly correlated to the instrumented variable and not affected by issues related to the specification of the model. Nevertheless, there is still the possibility that our instrument is correlated with other variables not explicitly taken into account in our

regression. In light of the existing literature on the impact of FDI, it is reasonable to assume that our instrument for FDI inflow is correlated with a negative competition effect provoking the exit of local firms from the market. Despite being explicitly acknowledged by many existing studies, this issue is rarely explicitly addressed in the literature mainly due to lack of data. Nonetheless, a negative competition effect due to the entry of MNEs with superior technological, managerial and organizational skills (Cantwell and Iammarino, 2003) crowding out local firms may impact the structure of the local production system weakening local innovative potentials. To control for this specific aspect, our instrument has been regressed over the provincial share of domestic companies in liquidation. Results reported in Table 7 rule out any doubts regarding a potential systematic correlation with our instrument.

The estimation of the impact of FDI on local innovative performance showed to be robust to a number of checks, encompassing the inclusion of additional controls and the implementation of the 2SLS estimation to address the endogeneity of the regressor of interest. The instrumental variable approach performed has passed a number of tests for weak instruments, model specifications and correlation with alternative relevant regressors. FDI proved to be a significant determinant of local innovative performance by enriching the knowledge base of Italian provinces and generating valuable positive knowledge externalities.

Conclusion

In the last few decades the attraction of FDI has been placed at the core of the policy agenda in both developed and developing countries. This centrality in the political debate is supported by the belief that the attraction of external resources could benefit recipient economies thanks to knowledge externalities arising from the localization of affiliates of MNEs endowed with superior technological, managerial and organizational skills.

However, existing academic literature suggests that local economic conditions are a crucial pre-requisite for valuable knowledge externalities to be successfully captured by local production systems and transformed in innovation.

So far there is weak consensus on whether knowledge externalities associated to FDI benefit systematically the economic and innovative performance of host locations. Such an inconclusiveness of the existing empirical literature is due to a number of flaws.

A first point concerns measurement issues associated to the adoption of proxies for both FDI and innovative performance. Traditionally, FDI is indirectly measured by indicators of foreign presence such as the share of employment in foreign firms or the number of foreign firms. These variables do not account for the actual size of foreign capital mixing up relevant financial investment with minor flows. At the same time, innovative performance is customary defined as TFP with problems connected to both the estimation of TFP itself and the indirect nature of this indicator as a measure for innovation.

A second concern regards the endogeneity related to the estimation of the causal impact of FDI. While early literature generally focuses on the correlation between FDI and outcome variables, more recently scholars have paid deeper attention to these sources of biasedness. However, there are still few attempts to track consistently this issue and more work is needed in this direction.

This paper aims at contributing to the existing debate with new evidences and attempts to address both the above mentioned problems. Firstly, we adopt a direct measure of FDI consisting of the real amount of capital flow in Italian provinces. Similarly, with the respect to local innovative performance, we consider a direct measure of innovation using patent data. This further implies relying on the estimation of the KFP which permits to overcome the methodological issues associated to TFP.

Secondly, we try to develop a novel identification strategy based on an IV approach. We adopt the shift-share methodology borrowing from the migration literature.

In our empirical exercise, we find that FDI contributes significantly to the patenting activities of Italian provinces over the period 2001-2006. This finding correlates with similar evidences provided by some previous empirical studies. Beside of this, it is worth noting that our investigation focuses on the gross impact of FDI without disentangling the channels through which knowledge externalities affect local economies. More research is needed to develop a robust investigation that contextually allows analysing the causal

impact of FDI while distinguishing the specific transmission mechanisms through which knowledge spills over space. This further direction for research will be possible along with improvements in the quality of data and it will remain a key interest in our future research agenda.

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Table 1: Variables List

Variable	Definition	Source	Geography	Time
Patents	Applications per million of inhabitants	OECD	Provincial	2001-2006
Private R&D	Share of expenditure for private R&D on GDP	ISTAT	Regional	2001-2006
Graduates	Share of graduates in science and technology on population	ISTAT	Regional	2001-2006
FDI	Millions in national currency	Bank of Italy	Provincial	2001-2006
Population Density	Population on provincial surface	ISTAT	Provincial	2001-2006
Value Added in Manufacturing	Millions in national currency	OECD	Provincial	2001-2006
Long Term Unemployment	Share of long term unemployed on population	ISTAT	Regional	2001-2006
Foreign Disinvestment	Millions in national currency	Bank of Italy	Provincial	2001-2006
Firms in Liquidation	Share of firms in liquidation on total number of firms	Unioncamere	Provincial	2001-2006

Notes: a) FDI and Foreign Disinvestment variables are weighted by provincial GDP, measured in millions of national currency (source: OECD); b) all variables are averaged over the period 2001-2006 and enter regressions in log form.

Table 2: Inward FDI and Local Innovative Performance

Dep Var: Innovative performance	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) OLS	(7) 2SLS
Private R&D	0.496***	0.360***	0.361***	0.297**	0.0538	0.0519	0.00622
	(0.110)	(0.125)	(0.126)	(0.135)	(0.0855)	(0.0834)	(0.110)
Graduates	0.495	0.568	0.555	0.482	0.200	0.214	0.459*
	(0.372)	(0.353)	(0.354)	(0.363)	(0.165)	(0.170)	(0.272)
FDI		0.133***	0.132***	0.0999***	0.0577**	0.0618***	0.242***
		(0.0347)	(0.0343)	(0.0343)	(0.0230)	(0.0219)	(0.0516)
Population Density			0.120	0.0926	0.244***	0.253***	0.222*
			(0.128)	(0.128)	(0.0900)	(0.0906)	(0.115)
Value added in Manufacturing				0.646***	0.182	0.163	-0.180
				(0.172)	(0.152)	(0.158)	(0.194)
Long Term Unemployment					-0.667***	-0.661***	-0.603***
					(0.143)	(0.142)	(0.150)
Foreign Disinvestments						-0.0142	-0.0382
						(0.0150)	(0.0275)
Constant	2.681***	3.300***	2.680**	3.894***	2.868***	2.660***	2.779***
	(0.939)	(0.928)	(1.153)	(1.159)	(0.689)	(0.765)	(1.011)
Macro-Regional Dummies	NO	NO	NO	NO	YES	YES	YES
Observations	103	103	103	103	103	103	103
R-squared	0.407	0.530	0.533	0.588	0.798	0.800	0.619

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 3: First Stage Regression

Dep.Var.: FDI Inflows	(1) OLS
Private R&D	0.1696
	(0.4157)
Graduates	-1.3744
	(0.8351)
Population Density	-0.8336
	(0.4625)
Value Added in Manufacturing	1.7319**
	(0.6761)
Long Term Unemployment	-0.3804
	(0.4516)
Foreign Disinvestments	0.0933
	(0.1000)
IV FDI	4.7589***
	1.3024
Constant	-0.2099
	(4.1144)
Macro-Regional Dummies	YES
Observations	103
R-squared	0.335

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 4: First Stage Statistics

Variable	F(1, 93)	P-Value
IV FDI	13.35	0.04

Table 5: Robustness Check (1)

Dep.Var.: Innovative Performance	(1) 2SLS	(2) 2SLS	(3) 2SLS	(4) 2SLS	(5) 2SLS	(6) 2SLS	(7) 2SLS
FDI	0.242***	0.206***	0.243***	0.255***	0.266***	0.282***	0.384***
	(0.0516)	(0.0405)	(0.0445)	(0.0462)	(0.0432)	(0.0518)	(0.0597)
Private R&D	0.00622	0.0128	0.200	0.234	0.223	0.404***	
	(0.110)	(0.101)	(0.150)	(0.152)	(0.149)	(0.119)	
Graduates	0.459*	0.377*	0.592	0.625*	0.640*		
	(0.272)	(0.213)	(0.367)	(0.361)	(0.365)		
Population Density	0.222*	0.206*	0.0819	0.0958			
	(0.115)	(0.110)	(0.128)	(0.133)			
Value Added in Manufacturing	-0.180	-0.0802	0.310*				
	(0.194)	(0.154)	(0.165)				
Long Term Unemployment	-0.603***	-0.604***					
	(0.150)	(0.112)					
Foreign Disinvestments	-0.0382						
	(0.0275)						
Constant	2.779***	3.231***	3.979***	3.379***	3.917***	5.614***	5.871***
	(1.011)	(0.851)	(1.199)	(1.204)	(0.928)	(0.311)	(0.379)
Macro-Regional Dummies	YES	NO	NO	NO	NO	NO	NO
Observations	103	103	103	103	103	103	103
R-squared	0.619	0.671	0.462	0.428	0.407	0.311	-0.071

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 6: Reduced Form Equation

Dep.Var.: Innovative Performance	(1) OLS
IV FDI	1.154***
	(0.405)
Private R&D	0.0473
	(0.0799)
Graduates	0.126
	(0.165)
Population Density	0.202**
	(0.0940)
Value Added in Manufacturing	0.239
	(0.157)
Long Term Unemployment	-0.695***
	(0.140)
Foreign Disinvestments	-0.0156
	(0.0152)
Constant	2.728***
	(0.760)
Macro-Regional Dummies	YES
Observations	103
R-squared	0.807

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 7: Robustness Check (2)

Dep.Var.: IV FDI	(1) OLS
Firms in Liquidation	0.157
	(0.0987)
Constant	0.654*
	(0.355)
Observations	103
R-squared	0.115

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1