Regional Studies

ISSN: 0034-3404 (Print) 1360-0591 (Online) Journal homepage: http://www.tandfonline.com/loi/cres20

Productivity, Credit Constraints and the Role of Short-Run Localization Economies: Micro-Evidence from Italy

Roberto Ganau

To cite this article: Roberto Ganau (2016) Productivity, Credit Constraints and the Role of Short-Run Localization Economies: Micro-Evidence from Italy, Regional Studies, 50:11, 1834-1848, DOI: 10.1080/00343404.2015.1064883

To link to this article: https://doi.org/10.1080/00343404.2015.1064883

View supplementary material

Published online: 07 Aug 2015.

Submit your article to this journal

Article views: 273

View Crossmark data

Citing articles: 1 View citing articles

Full Terms & Conditions of access and use can be found at
http://www.tandfonline.com/action/journalInformation?journalCode=cres20

Regional Studies, 2016
Vol. 50, No. 11, 1834–1848, http://dx.doi.org/10.1080/00343404.2015.1064883

Productivity, Credit Constraints and the Role of Short-Run Localization Economies: Micro-Evidence from Italy

ROBERTO GANAU
Department of Economics and Management, University of Padova, Via del Santo, 33, I-35123 Padua, Italy.
Email: roberto.ganau@studenti.unipd.it

(Received November 2013; in revised form June 2015)

GANAU R. Productivity, credit constraints and the role of short-run localization economies: micro-evidence from Italy, *Regional Studies*. This paper investigates whether Italian manufacturing firms' productivity is affected by credit constraints, and whether short-run localization economies foster productivity both directly and indirectly, moderating the negative effects of credit rationing via inter-firm credit relationships. Results suggest a negative effect of credit rationing on firms' productivity, while a positive relationship exists between short-run localization economies and productivity. It emerges that location in an industrially concentrated area reduces firms' investment-to-cash flow sensitivity, and that it positively moderates the negative effect of credit rationing on productivity. Moreover, the positive moderation effect seems to be increasing in the density of the local banking system.

Total factor productivity Credit rationing Localization economies

GANAU R. 生产力、信贷限制以及短期在地化经济的角色：意大利的微观证据，*区域研究*。本文探讨意大利製造厂商的生产力，是否会受到信贷限制的影响，以及短期的在地化经济，是否会同时直接与间接地促进生产力，并透过厂商之间的信贷关係，减轻信贷配额的负面效应。研究结果显示，信贷配额对厂商的生产力有负面的影响，而短期的在地化经济和生产力之间，则存在着正向关係。结果显示，位于产业集中的地区之区位，减少了厂商的投资对现金流量敏感度，且正面地缓和了信贷配额对生产力的负面效应。此外，正向的缓和效应，似乎在地方银行系统的密度中增加。

全要素生产力 信贷配额 在地化经济

GANAU R. La productivité, les contraintes de crédit et le rôle des économies de localisation à court terme: des résultats micro-économiques provenant de l'Italie, *Regional Studies*. Cet article cherche à examiner si, oui ou non, la productivité des entreprises de fabrication italiennes est touchée par les contraintes de crédit, et si les économies de localisation à court terme favorisent la productivité à la fois directement et indirectement, modérant ainsi les effets négatifs du rationnement du crédit par moyen des relations de crédit interentreprises. Les résultats laissent supposer que le rationnement du crédit exerce un effet négatif sur la productivité des entreprises, alors qu'il existe une relation positive entre les économies de localisation à court terme et la productivité. Il s'avère que la localisation d'une entreprise dans une zone fortement industrialisée réduit la sensibilité de son investissement au cash-flow, et qu'il modère de façon positive l'effet négatif du rationnement du crédit sur la productivité. En outre, l'effet de modération positif semble augmenter, vu la densité du système bancaire local.

Productivité totale des facteurs Rationnement du crédit Économies de localisation

GANAU R. Produktivität, Kreditbeschränkungen und die Rolle von kurzfristigen Lokalisationsökonomien: Mikrobelege aus Italien, *Regional Studies*. In diesem Beitrag wird untersucht, ob die Produktivität von italienischen produzierenden Betrieben durch Kreditbeschränkungen beeinflusst wird und ob kurzfristige Lokalisationsökonomien die Produktivität sowohl unmittelbar als auch mittelbar fördern, indem sie die negativen Auswirkungen einer Kreditrationierung mithilfe von Kreditbeziehungen zwischen Firmen abschwächen. Die Ergebnisse lassen auf eine negative Auswirkung der Kreditrationierung auf die Produktivität der Firmen schließen, während zwischen kurzfristigen Lokalisationsökonomien und der Produktivität eine positive Beziehung besteht. Es stellt sich heraus, dass der Standort in einer industriell konzentrierten Gegend die Investitionen-Cashflow-Sensibilität der Firmen verringert und die negative Auswirkung der Kreditrationierung auf die Produktivität positiv abschwächt. Darüber hinaus scheint der positive Abschwächungseffekt mit der Dichte des lokalen Bankwesens zuzunehmen.

Gesamtfaktorproduktivität Kreditrationierung Lokalisationsökonomien

© 2015 Regional Studies Association
http://www.regionalstudies.org

GANAU R. Productividad, restricciones de crédito y el papel de las economías de localización a corto plazo: micro-evidencia de Italia, *Regional Studies*. En este artículo se investiga si la productividad de las empresas manufactureras italianas está afectada por las restricciones de crédito, y si las economías de localización a corto plazo fomentan la productividad tanto directa como indirectamente, moderando los efectos negativos del racionamiento del crédito a través de las relaciones de créditos entre empresas. Los resultados indican un efecto negativo del racionamiento del crédito en la productividad de las empresas y una relación positiva entre las economías de localización a corto plazo y la productividad. Se observa que la ubicación en una zona concentrada industrialmente reduce la sensibilidad de las empresas en cuanto a la inversión al flujo de caja, y que modera positivamente el efecto negativo del racionamiento del crédito en la productividad. Además, el efecto de moderación positivo parece aumentar con la densidad del sistema bancario local.

Productividad total de los factores   Racionamiento del crédito   Economías de localización

JEL classifications: C23, D24, G32, R12

INTRODUCTION

The determinants of firms' productivity have been widely investigated (SYVERSON, 2011) and some contributions have also considered, besides traditional factors, the role of financial variables (CARREIRA and SILVA, 2010) and agglomeration economies (ROSENTHAL and STRANGE, 2004). On the one hand, contributions studying the effects of credit rationing on firms' productivity underline a negative credit constraints–productivity relationship. Firms facing difficulties in obtaining credit from banks and institutional markets have to rely on internally generated resources, thus being limited in their investment decisions with negative effects on productivity (CHEN and GUARIGLIA, 2013). On the other hand, the literature on agglomeration economies emphasizes how positive externalities arising from the local economic environment foster firms' productivity. Firms in agglomerated areas benefit from spillover effects in terms of external-scale economies, the reduction of transaction costs, knowledge transmission and, in particular, localization externalities seem to play a key role in enhancing firms' productivity (BEAUDRY and SCHIFFAUEROVA, 2009).

This paper contributes to the literature on the determinants of firms' productivity by linking the abovementioned research streams. It investigates whether Italian manufacturing firms' productivity is sensitive to credit constraints, whether it is fostered by short-run localization externalities, and whether location in industrially concentrated areas downsizes the negative effect of credit constraints on productivity. In fact, the geographic concentration of industries may positively moderate the credit constraints–productivity relationship promoting inter-firm trade credit as an alternative source of funds, which has been found particularly relevant in specialized productive clusters (DEI OTTATI, 1994).

The analysis employs a sample of 11 953 Italian manufacturing firms observed over the period 1999–2007. Results suggest a negative credit constraints–productivity relationship, while a positive relationship exists between localization externalities and productivity. Geographic concentration positively moderates firms' investment-to-cash flow sensitivity, and reduces the negative credit constraints–productivity relationship. Finally, the moderation effect of localization externalities is increasing in the density of bank branches.

The paper is organized as follows. The second section discusses the related literature. The third section describes the dataset and methodology. The fourth section presents the results. The fifth section concludes.

RELATED LITERATURE

Credit constraints and productivity

Many theoretical contributions underline the importance of financial markets in promoting economic growth through the provision of resources necessary to finance productivity-enhancing technological innovations (KING and LEVINE, 1993). Along these lines, several contributions focused on the relationship between finance and firms' investment decisions. The rationale is that financial markets may finance firms to undertake new investment projects, and they may facilitate efficient resources allocation and capital accumulation (AGHION *et al.*, 2010). However, under the assumptions of imperfect financial markets and asymmetric information, firms may face difficulties in raising credit from banks and institutional markets. Consequently, credit-constrained firms have to rely on internal funds, and they cannot allocate efficiently their resources to undertake productivity-enhancing investments (AYYAGARI *et al.*, 2007).

Evidence shows negative effects of credit rationing on firms' investments (FAZZARI *et al.*, 1988; LOVE, 2003; GUARIGLIA, 2008), and since investments represent key sources of productivity, a relationship between financial factors and firms' productivity is likely to emerge (GATTI and LOVE, 2008; CHEN and GUARIGLIA, 2013). Suppose a firm faces two possible scenarios: either it can get the resources needed to finance new productivity-enhancing investments from financial institutions, or financial markets' imperfections are such that a firm cannot raise external funds to finance investments. In the first case, firms will undertake new projects independently of cash flow availability. In the second case, firms willing to make new investments have to rely on internal resources with the consequence that decisions on new investments are subject to cash flow availability. It follows that credit-constrained firms can enhance their productivity only if they have internally the resources required to undertake productivity-enhancing investments. Hence, the more firms are credit constrained, the more their investment decisions depend on cash flow availability and, consequently, the higher it turns to be the sensitivity of productivity to credit rationing.

For the Italian case, ALBARETO and FINALDI RUSSO (2012) underline that the share of manufacturing firms (with at least 50 employees) asking for credit but not receiving it increased by more than 3% over the period 1999–2003, while it decreased from about 6.5% to about 2% over the period 2003–07. Similarly, the total factor productivity (TFP) in the manufacturing industry decreased by 3.51% over the period 1999–2003, while it decreased by 0.90% over the period 2003–07. This evidence suggests a relationship between external funds' availability and manufacturing firms' productivity during the period investigated in this paper. Therefore, the following hypothesis is specified:

Hypothesis 1: Firms are credit constrained, and their productivity is negatively affected by credit rationing.

Localization economies and productivity

The literature on agglomeration economies, which can be defined as local and spatially bounded sources of positive externalities arising from the geographic proximity of economic actors (ROSENTHAL and STRANGE, 2004), builds on the idea that agglomeration induces tangible and intangible benefits for local economic agents, which translate in productivity growth both at firm and local levels (PUGA, 2010).

Localization externalities arising from the spatial concentration of firms operating in the same industry received much attention. GLAESER *et al.* (1992) formalized their role in the Marshall–Arrow–Romer (MAR) model (MARSHALL, 1920; ARROW, 1962; ROMER, 1986), which claims that firms within the same industry and located in a spatially bounded area benefit from intra-industry knowledge and technological spillovers facilitated by the transmission of information: the sharing of a common competence base allows effective learning of new or transmitted knowledge, which requires cognitive proximity among actors (NOOTEBOOM, 2000). Localization economies may also produce advantages concerning the reduction of transportation costs, the emerging of external-scale economies, and the availability of highly specialized workers and inputs' suppliers, all representing sources of higher productivity for firms (DURANTON and PUGA, 2004; MARTIN *et al.*, 2011). The general result of firm-level studies on the agglomeration–productivity relationship is that localization economies tend to foster firms' productivity (see BEAUDRY and SCHIFFAUEROVA, 2009, for a review of empirical works).

The contribution of this paper to the existing literature is twofold. First, it analyses whether localization economies directly affect firms' productivity. Specifically, short-run economies are analysed since the empirical investigation considers yearly levels of firms' productivity. Short-run agglomeration economies tend to capture labour and input markets-related externalities, while knowledge-based spillovers may require a longer time interval to materialize (MARTIN *et al.*, 2011). Therefore, the analysis focuses on the supply-side advantages of agglomeration economies, i.e. those related to the sharing of intermediate inputs' suppliers, the matching between buyers and suppliers, and the sharing of a pool of specialized workers (PUGA, 2010). This leads to the following hypothesis:

Hypothesis 2: Sort-run localization economies foster firms' productivity.

Second, this paper investigates whether localization economies have also an indirect positive effect on productivity by relating the analysis of agglomeration economies to that of credit constraints. Being part of a highly agglomerated area may allow firms (partially) to overcome the negative effects of credit rationing thanks to inter-firm relationships, which materialize on both the productive and the financial sides. Production linkages may entail inter-firm credit relationships (CAINELLI *et al.*, 2012), which represent an alternative, non-institutional channel through which firms can alleviate financial constraints (MENICHINI, 2011; FERRANDO and MULIER, 2013).

Inter-firm credit realizes in a circular way: firms can obtain credit from suppliers through better contracts or delayed payments and, vice versa, they can extend credit to customers (FERRANDO and MULIER, 2013). Inter-firm credit has been found to be particularly relevant in productive clusters, e.g. Italian industrial districts: evidence shows that geographic proximity, reciprocity, and repeated transactions between suppliers and customers increase reputation and trust and reduce asymmetric information problems, thus favouring inter-firm credit relationships (DEI OTTATI, 1994; UGHETTO, 2009; SCALERA and ZAZZARO, 2011).

Geographic concentration of firms within an industry is an industrial district-type source of external economies, and localization externalities diffuse across firms often related by production linkages. Therefore, geographic concentration may alleviate firms' credit constraints promoting inter-firm trade credit (via production linkages, mainly based on input sharing) among firms in the local system, thus favouring a reduction of the negative effects of credit rationing on productivity. Hence, the following hypothesis is specified:

Hypothesis 3: Geographic concentration alleviates firms' credit constraints, thus reducing the negative effects of credit rationing on productivity.

DATA AND METHODOLOGY

The dataset

The analysis employs balance sheet data drawn from the AIDA databank (Bureau Van Dijk). The dataset was constructed by considering manufacturing firms with positive values of turnover and value added over seven consecutive years during the period 1998–2007, and reporting a value added-to-turnover ratio ≥ 0 and ≤ 1. Firms in the first and last percentiles of the sales growth distribution have been removed to avoid outlying observations, as well as firms with inconsistent data in terms of value added, total labour costs, tangible assets, production costs, net income and annual depreciation. This first cleaning procedure left an unbalanced panel of 12 524 firms observed over the period 1999–2007, which was used to estimate firms' productivity. The final dataset, resulting in an unbalanced panel of 11 953 firms observed over the period 1999–2007, was obtained by removing firms without information on their year of set up, their location at the provincial level (NUTS-3 level of the European Union territorial classification – Nomenclature des Unités Territoriales Statistiques), and employment. Appendix A in the supplemental data online describes the structure of the sample and discusses potential drawbacks.

Econometric methodology

The analysis is conducted in three steps. First, firms' TFP is estimated by employing the approach proposed by Wooldridge (2009). Second, dynamic investment equations are estimated to investigate whether firms are credit constrained, and to test the potential moderation effect of geographic concentration on the investment-to-cash flow sensitivity. Third, an instrumental-variable approach is employed to test whether productivity is negatively affected by credit constraints (the marginal effect of cash flow on investments), and whether geographic concentration positively affects productivity both directly and indirectly, downsizing the (potential) negative effect of credit rationing.

Productivity estimation. Firms' TFP is estimated as the residual of a Cobb–Douglas production function that, taking logarithms, can be specified as follows:

$$y_{it} = \beta_0 + \beta_k k_{it} + \beta_l l_{it} + u_{it} + \eta_{it} \quad (1)$$

where β_0 represents the mean efficiency level across firms and over time; y_{it}, k_{it} and l_{it} represent, respectively, value added, capital input and labour input of firm i at time t; η_{it} is an independent and identically distributed (i.i.d.) component representing productivity shocks not affecting a firm's decision process; and:

$$\omega_{it} = \beta_0 + u_{it}$$

represents firm-level productivity, assuming that ω_{it} is a state variable-transmitted component affecting a firm's decision process (Van Beveren, 2012). The estimated productivity is then obtained by solving for ω_{it}:

$$\hat{\omega}_{it} = \hat{\beta}_0 + \hat{u}_{it} = y_{it} - \hat{\beta}_k k_{it} - \hat{\beta}_l l_{it} \quad (2)$$

Ordinary least squares (OLS) or fixed effects (FE) estimation of equation (1) lead to biased productivity estimates due to the 'simultaneity bias', which concerns some form of endogeneity in the inputs due to the correlation between the level of inputs chosen by the firm and unobservable productivity shocks. This problem emerges since firms can choose the level of inputs on the base of prior beliefs on productivity levels, which, however, cannot be observed by the econometrician (Syverson, 2011).

Building on the two-step semi-parametric approach proposed by Levinsohn and Petrin (2003), which uses intermediate inputs (m_{it}) as proxy variable to control for unobserved productivity, thus solving the simultaneity problem between input choices and productivity shocks, Wooldridge (2009) proposes to estimate β_k and β_l by using a more efficient one-step generalized method of moments (GMM) estimator, thus correcting possible collinearity between labour and intermediate inputs characterizing Levinsohn and Petrin's (2003) approach (Ackerberg *et al.*, 2006).[1] Wooldridge (2009) suggests estimating simultaneously two equations with the same dependent variable and the same set of input variables, while different sets of instruments are specified so that the coefficients of the input variables in the first equation are identified by exploiting information in the second equation. Given a production function (1), and assuming absence of correlation of η_{it} with current and past values of capital, labour and intermediate inputs, and restriction of the dynamics of the unobserved productivity component (ω_{it}), β_k and β_l can be identified by estimating the following two equations:

$$\begin{cases} y_{it} = \beta_0 + \beta_k k_{it} + \beta_l l_{it} + g(k_{it}, m_{it}) + \eta_{it} \\ y_{it} = \beta_0 + \beta_k k_{it} + \beta_l l_{it} + j[g(k_{it-1}, m_{it-1})] + \eta_{it} + a_{it} \end{cases} \quad (3)$$

where a_{it} denotes productivity innovations and is correlated with l_{it} and m_{it}, while it is uncorrelated with k_{it} and past values of k_{it}, l_{it} and m_{it}; $g(\cdot)$ may be specified as a low-degree polynomial of order up to three; and $j(\cdot)$ (i.e. the productivity process) may be defined as a random walk with drift, such that:

$$\omega_{it} = \tau + \omega_{it-1} + a_{it}$$

Then, equation (1) can be re-specified as follows (GALUŠČÁK and LÍZAL, 2011):

$$y_{it} = (\beta_0 + \tau) + \beta_k k_{it} + \beta_l l_{it} + g(k_{it-1}, m_{it-1}) + \eta_{it} + a_{it} \quad (4)$$

and can be estimated through an instrumental-variable approach using polynomials in k_{it-1} and m_{it-1} of order up to three approximating for $g(\cdot)$; and k_{it}, k_{it-1}, l_{it-1}, m_{it-1} and polynomials containing m_{it-1} and k_{it-1} of order up to three as instruments for l_{it} (PETRIN and LEVINSOHN, 2012). Appendix B in the supplemental data online describes the variables entering the production function and presents results of the TFP estimation.

Credit constraints and localization economies. The following dynamic investment equation is estimated to evaluate whether firms are affected by credit constraints, and if geographic concentration reduces the investment-to-cash flow sensitivity (BOND and VAN REENEN, 2007):

$$\left(\frac{\mathrm{I}}{\mathrm{Kb}}\right)_{igpt} = \beta_0 + \beta_1\left(\frac{\mathrm{I}}{\mathrm{Kb}}\right)_{igpt-1} + \beta_2\left(\frac{\mathrm{CF}}{\mathrm{Kb}}\right)_{igpt} + \beta_3\Delta\mathrm{SALES}_{igpt} + \beta_4\mathrm{GC}_{gpt} + \beta_5\mathrm{URB}_{pt} + \beta_6\left(\frac{\mathrm{CF}}{\mathrm{Kb}}\right)_{igpt} \times \mathrm{GC}_{gpt} + \beta_7\mathrm{TFP}_{igpt} + \beta_8\mathrm{SIZE}_{igpt} + \beta_9\mathrm{AGE}_{igpt} + \varepsilon_{igpt}$$

$$\varepsilon_{igpt} = \nu_i + \nu_t + \nu_g + \nu_r + \nu_{igpt} \quad (5)$$

where $(\mathrm{I/Kb})_{igpt}$ is the logarithm of the ratio between firm investments in real terms (I_{igpt}) and capital stock at the beginning of the period (Kb_{igpt}) of the ith firm operating in the two-digit industrial sector g and located in province p at time t. The right-hand side of equation (5) includes the first-order time-lagged dependent variable; the cash flow variable $(\mathrm{CF/Kb})_{igpt}$ to capture the effect of credit constraints; the term:

$$\Delta\mathrm{SALES}_{igpt} = \mathrm{SALES}_{igpt} - \mathrm{SALES}_{igpt-1}$$

to capture the short-run response of investments to demand shocks (where SALES_{igpt} is the logarithm of deflated sales); the term GC_{gpt} to capture localization economies; the term URB_{pt} to capture urbanization economies; and the interaction term between $(\mathrm{CF/Kb})_{igpt}$ and GC_{gpt} to capture the potential moderation effect of geographic concentration on the investment-to-cash flow sensitivity. The variables TFP_{igpt}, SIZE_{igpt} and AGE_{igpt} capture firms' productivity, size and age. The composite error term, ε_{igpt}, is defined as the sum of five components: ν_i captures firm-specific effects; ν_t represents time fixed effects defined by a set of year dummies; ν_g captures industry-specific effects defined by a set of two-digit industrial sector dummies; ν_r represents geographic fixed effects at the NUTS-2 level capturing structural differences across Italian regions; and ν_{igpt} denotes the error term.

The cash flow variable is defined as the logarithm of the ratio between cash flow (CF_{igpt}) and capital stock at the beginning of the period. Cash flow is generally used in the financial literature to proxy for internal resources availability and to capture the sensitivity of a firm's performance measure to credit constraints (CARREIRA and SILVA, 2010). Since credit constrained firms have to rely on internal resources to finance new investments, additional cash flow allows them to optimize real investments. Hence, a positive coefficient of the cash flow variable means that firms are facing difficulties in raising external capitals, and the higher is the marginal effect of cash flow on investments, the more firms are affected by credit rationing.[2]

Localization externalities are captured by an index of geographic concentration of industries measured as follows (CAINELLI *et al.*, 2015):

$$\mathrm{GC}_{gpt} = \ln(\mathrm{N}_{gpt}/\mathrm{A}_p) \quad (6)$$

where N_{gpt} denotes the number of firms operating in the industrial sector g and located in province p at time t; and A_p is the area of province p (km^2). The variable capturing urbanization externalities is defined as follows (MELO and GRAHAM, 2009):

$$\mathrm{URB}_{pt} = \ln(\mathrm{N}_{pt}/\mathrm{A}_p) \quad (7)$$

where N_{pt} denotes the total number of firms located in province p at time t. The use of density measures to proxy for agglomeration economies has two main advantages: it is robust to differences in land area sizes, and it captures well the benefits arising from the spatial concentration of economic activities (CICCONE and HALL, 1996).[3]

The interaction term between the variables for cash flow and geographic concentration aims at capturing a (potential) moderation effect of the agglomeration on the investment-to-cash flow sensitivity. Firms operating in agglomerated areas and characterized by robust and long-lasting relationships with neighbour firms (suppliers and customers) can benefit from positive externalities which materialize in delayed or long-term payments and better contracts. Hence, increasing trust among entrepreneurs allows inter-firm credit, which may downsize firms' dependence on internal resources, thus alleviating credit constraints. A negative coefficient of the interaction term means a positive moderation effect of geographic concentration, i.e. that dependence on internal resources decreases as the level of geographic concentration increases.

Firm productivity is the residual of the estimated equation (4), firm size is defined as the logarithm of the total number of employees, while firm age is defined as the logarithm of the difference between the year of observation and the year of firm set up.

Productivity, credit constraints and localization economies. Equation (8) is specified to analyse the effect of credit constraints and the direct (and indirect) effect of geographic concentration on productivity:

$$\begin{aligned} \mathrm{TFP}_{igpt} = \beta_0 &+ \beta_1 \mathrm{GC}_{gpt} + \beta_2 \mathrm{URB}_{pt} \\ &+ \beta_3 \mathrm{CC}_{igpt} + \beta_4 \mathrm{SIZE}_{igpt} + \beta_5 \mathrm{AGE}_{igpt} \\ &+ \beta_6 \mathrm{WAGE}_{igpt} + \beta_7 \mathrm{VERTICAL}_{igpt} \\ &+ \beta_8 \mathrm{SALES}_{igpt} + \beta_9 \mathrm{VA}_{pt} \\ &+ \beta_{10} \Delta \mathrm{VA}_{pt} + \alpha_i + \gamma_t + \nu_{igpt} \end{aligned} \tag{8}$$

where TFP_{igpt} is the estimated productivity from equation (4). The terms GC_{gpt} and URB_{pt} capture the direct effect of localization and urbanization economies. Short-run localization externalities are expected to foster firms' productivity favouring the emerging of external-scale economies, the reduction of transportation costs, and the availability of specialized inputs' suppliers and workers (MARTIN *et al.*, 2011). The urbanization variable allows to control for scale economies arising from the concentration of all economic activities (ROSENTHAL and STRANGE, 2004). Location in large urban areas may benefit firms, increasing the probability to access to specialized business services as well as to public facilities, infrastructures, transportation systems, and knowledge produced by private and public actors (JACOBS, 1969; MELO *et al.*, 2009; PUGA, 2010).

The term CC_{igpt} denotes credit constraints. It is computed as the marginal effect of cash flow on investments from equation (5), and it allows one to test for both the direct credit constraints–productivity relationship and the indirect effect of geographic concentration on productivity. If $\beta_3 < 0$ in equation (8), then productivity is negatively affected by credit rationing. Moreover, by letting β_3^1 and β_3^2 be the estimated coefficients of the CC_{igpt} variable in equation (8) when the CC_{igpt} variable is obtained by estimating equation (5), respectively, without and with the inclusion of the interaction term between cash flow and geographic concentration, then $\beta_3^2 < \beta_3^1$ means that geographic concentration has an indirect positive effect since it reduces the negative effect of credit rationing on productivity.

The terms SIZE_{igpt}, AGE_{igpt}, WAGE_{igpt}, $\mathrm{VERTICAL}_{igpt}$ and SALES_{igpt} represent firm-specific time-varying control variables, where WAGE_{igpt} is the logarithm of deflated wages and $\mathrm{VERTICAL}_{igpt}$ captures the degree of services outsourcing. The variables VA_{pt} and $\Delta\mathrm{VA}_{pt}$ denote, respectively, the logarithm of deflated value added in province p at time t and its growth between periods t and $t-1$, and they are included to capture the dynamics of the performance of the province where firms operate. The terms α_i and γ_t capture, respectively, firm and time fixed effects, while ν_{igpt} is an error term.

Robustness exercise. The investment equation (5) is modified to control for the role of the local banking system including a measure of operational proximity (OP_{pt}) defined as follows (ALESSANDRINI *et al.*, 2009):

$$\mathrm{OP}_{pt} = \ln\left[\left(\frac{\mathrm{BB}_{pt}}{\mathrm{POP}_{pt}}\right) * 10\,000\right] \tag{9}$$

where BB_{pt} denotes the number of bank branches located in province p at time t; and POP_{pt} denotes the population living in the corresponding province.[4] This variable allows one to control for the effect of the concentration of the banking system on firms' investment decisions. On the one hand, little physical distance between borrower and lending office allows the bank to supplement 'hard' information with 'soft' information collected at the local level, which facilitate screening and monitoring activities, and relationship lending. Moreover, firms may easily get access to financial resources as the number of bank branches in the local area increases due to higher competition in the local credit market. On the other hand, little physical distance may have negative effects on investment decisions if local banks charge higher interest rates to the closest borrowers due to information rents or transportation costs (ALESSANDRINI *et al.*, 2009). Finally, a three-way interaction term is included in the investment equation to capture the joint effect of localization externalities and banks' density on the investment-to-cash flow sensitivity. Appendix C in the supplemental data online reports descriptive statistics, the correlation matrix and the definition of the main variables.

Estimation issues. The estimation of equations (5) and (8) leads to two main econometric issues: unobserved heterogeneity and endogeneity of the explanatory variables.

The two-step system GMM (SYS-GMM) estimator is employed to estimate equation (5) because, in the context of dynamic panel data, a simple instrumental-variable estimator produces a biased coefficient of the time-lagged dependent variable (WOOLDRIDGE, 2002). The SYS-GMM estimator combines a system of first-differenced variables (removing unobserved heterogeneity) instrumented with lagged levels, and a system of variables in level instrumented with lags of their own first differences (ARELLANO and BOVER, 1995; BLUNDELL and BOND, 1998). The variables capturing firm age and industry, geographic, and time fixed effects are treated as exogenous and are used as instruments for themselves only in levels. The time-lagged dependent variable and the variables for cash flow, productivity, size and operational proximity are instrumented using their values lagged 3–6 in both levels and first differences, while the sales growth variable is instrumented using its values lagged 3–6 only in levels. The geographic concentration and urbanization variables are instrumented using their 1971 values, plus the logarithm of a population density measure (population in the province/km^2) dated 1921.

The static nature of equation (8) allows one to employ instrumental-variable FE estimators to deal with unobserved heterogeneity and endogeneity. In particular, reverse causality between firms' productivity and agglomeration economies is likely to emerge: on the one hand, agglomeration economies may foster firms' productivity; on the other hand, firms' location choices could be influenced by high levels of productivity with the consequence that firms could migrate towards the most productive areas, thus reinforcing the agglomeration itself (ROSENTHAL and STRANGE, 2004; GRAHAM *et al.*, 2010). Since the FE estimator prevents the use of time-invariant instruments (e.g. long lags of the agglomeration variables), agglomeration variables are instrumented using the difference between their values at time $t-1$ and in 1971:

$$\Delta \text{GC}_{gpt-1} = \text{GC}_{gpt-1} - \text{GC}_{gp1971}$$
$$\Delta \text{URB}_{pt-1} = \text{URB}_{pt-1} - \text{URB}_{p1971}$$

and the difference between population density at time $t-1$ and in 1921:

$$\Delta \text{PD}_{pt-1} = \ln(\text{PD}_{pt-1}) - \ln(\text{PD}_{p1921})$$

Besides the two-stage least squares (TSLS) estimator, the GMM estimator with optimal weighting matrix is employed because it is more efficient in the case of heteroskedastic errors (CAMERON and TRIVEDI, 2005).

The validity of the estimation methodology is assessed through ARELLANO and BOND's (1991) test of serial correlation for dynamic panel data, HANSEN's (1982) *J*-statistic of over-identifying restrictions, first-stage *F*-statistics to test instruments' relevance in the TFP equation, and the Lagrange Multiplier (LM) version of KLEIBERGEN and PAAP's (2006) rank statistic to test the null hypothesis of under-identification of the matrix of reduced-form coefficients.[5]

EMPIRICAL RESULTS

Table 1 reports results of the investment and TFP equations estimated without controlling for (Model 1) and controlling for (Model 2) the moderation effect of geographic concentration. Diagnostic tests for the investment equations support the estimation strategy: ARELLANO and BOND's (1991) test highlights the absence of third-order serial correlation in the first-differenced residuals, and the null hypothesis of instruments' exogeneity is never rejected since *p*-values of HANSEN's (1982) *J*-statistic are never significant. Similarly, diagnostic tests support the instrumental-variable estimation of the TFP equations: *p*-values of Hansen's *J*-statistic are never significant; first-stage *F*-statistics on excluded instruments referring to the agglomeration variables have *p*-values equal to zero in all cases, thus suggesting a good predictive power of the chosen instruments; KLEIBERGEN and PAAP's (2006) rank statistic always rejects the null hypothesis that the matrix of reduced-form coefficients is under-identified, thus maintaining the instruments' relevance. Moreover, the mean variance inflation factor (VIF) is lower than the conservative cut-off value of 10 in all specifications, thus suggesting the absence of multicollinearity problems (NETER *et al.*, 1985).

Results of the investment equations show positive and significant coefficients of cash flow, meaning that firms are affected by credit rationing. The coefficient of the interaction term between cash flow and geographic concentration is negative and statistically significant, thus suggesting that localization externalities positively moderate the investment-to-cash flow sensitivity favouring inter-firm trade credit.

Results suggest time persistence of the investment dynamics, while there is no evidence of short-run adjustment in the investment decisions due to demand shocks. The TFP and age variables show negative and significant coefficients, while the size variable has positive and significant coefficients. The coefficients of the agglomeration variables are negative but non-significant in the main terms.

Results of the TFP equations show a positive and significant direct effect of localization externalities on firms' productivity, while the coefficients of the urbanization variable are never significant. This last result may depend on the short-run nature of the analysis, since urbanization economies tend to materialize in the long run due to the fact that inter-industry spillovers may

Table 1. Results of investment and total factor productivity (TFP) equations

Model	(1)				(2)			
Dependent variable	$(I/Kb)_{igpt}$	TFP_{igpt}			$(I/Kb)_{igpt}$	TFP_{igpt}		
Estimation method	SYS-GMM	FE	FE-TSLS	FE-GMM	SYS-GMM	FE	FE-TSLS	FE-GMM
$(I/Kb)_{igpt-1}$	0.416***	…	…	…	0.422***	…	…	…
	(0.035)				(0.036)			
$(CF/Kb)_{igpt}$	0.289***	…	…	…	0.193***	…	…	…
	(0.044)				(0.071)			
$\Delta SALES_{igpt}$	0.072	…	…	…	0.070	…	…	…
	(0.046)				(0.044)			
GC_{gpt}	−0.002	0.218*	0.572**	0.545**	−0.076**	0.214*	0.570**	0.543**
	(0.021)	(0.119)	(0.230)	(0.230)	(0.036)	(0.121)	(0.232)	(0.231)
URB_{pt}	−0.008	−0.568	0.657	0.468	−0.005	−0.560	0.701	0.513
	(0.024)	(0.417)	(1.708)	(1.705)	(0.022)	(0.420)	(1.715)	(1.711)
$(CF/Kb)_{igpt} \times GC_{gpt}$	…	…	…	…	−0.050**	…	…	…
					(0.020)			
CC_{igpt}	…	−0.164***	−0.164**	−0.167**	…	−0.119***	−0.119*	−0.122**
		(0.048)	(0.076)	(0.076)		(0.043)	(0.062)	(0.062)
TFP_{igpt}	−0.151**	…	…	…	−0.142**	…	…	…
	(0.067)				(0.067)			
$SIZE_{igpt}$	0.188***	0.091**	0.093**	0.094**	0.182***	0.088*	0.090**	0.090**
	(0.056)	(0.045)	(0.040)	(0.040)	(0.055)	(0.045)	(0.040)	(0.040)
AGE_{igpt}	−0.072***	−0.010	−0.023	−0.019	−0.071***	−0.006	−0.019	−0.015
	(0.025)	(0.140)	(0.109)	(0.109)	(0.025)	(0.140)	(0.110)	(0.109)
$WAGE_{igpt}$	…	0.082*	0.085**	0.086**	…	0.081*	0.084**	0.086**
		(0.048)	(0.043)	(0.043)		(0.048)	(0.043)	(0.043)
$VERTICAL_{igpt}$	…	−0.168	−0.156	−0.161	…	−0.150	−0.138	−0.143
		(0.138)	(0.117)	(0.116)		(0.136)	(0.116)	(0.116)
$SALES_{igpt}$	…	0.005	0.005	0.005	…	0.004	0.004	0.004
		(0.003)	(0.004)	(0.004)		(0.003)	(0.004)	(0.004)
VA_{igpt}	…	0.489	−0.199	−0.075	…	0.482	−0.221	−0.098
		(0.576)	(0.900)	(0.897)		(0.576)	(0.903)	(0.901)
ΔVA_{igpt}	…	−0.584	−0.322	−0.388	…	−0.600	−0.331	−0.398
		(0.512)	(0.639)	(0.637)		(0.516)	(0.641)	(0.639)
Number of observations	70 711	70 711	70 711	70 711	70 711	70 711	70 711	70 711
Number of firms	11 953	11 953	11 953	11 953	11 953	11 953	11 953	11 953
Number of instruments	191	…	…	…	192	…	…	…
AR(1) (*p*-value)	0.000	…	…	…	0.000	…	…	…
AR(2) (*p*-value)	0.000	…	…	…	0.000	…	…	…
AR(3) (*p*-value)	0.645	…	…	…	0.641	…	…	…
Hansen *J*-statistic (*p*-value)	0.237	…	0.154	0.154	0.276	…	0.155	0.155
R^2	…	0.009	…	…	…	0.006	…	…

(*Continued*)

Table 1. Continued

Model	(1)				(2)			
Dependent variable	$(I/Kb)_{igpt}$	TFP_{igpt}			$(I/Kb)_{igpt}$	TFP_{igpt}		
Estimation method	SYS-GMM	FE	FE-TSLS	FE-GMM	SYS-GMM	FE	FE-TSLS	FE-GMM
Kleibergen–Paap rk LM-statistic (p-value)	…	…	0.000	0.000	…	…	0.000	0.000
F-statistic on GC_{gpt} (p-value)	…	…	0.000	0.000	…	…	0.000	0.000
F-statistic on URB_{pt} (p-value)	…	…	0.000	0.000	…	…	0.000	0.000
Mean VIF	1.17	1.58	1.58	1.58	1.75	1.58	1.58	1.58

Notes: Bootstrapped standard errors are shown in parentheses and are clustered at province–industrial sector level (1291 units). Investment equations are estimated using a two-step system GMM estimator, with WINDMEIJER's (2005) correction; they include a constant term, industrial sector, NUTS-2 and year dummies. The dummy and age variables are used as instruments for themselves only in levels. The GC_{gpt} and URB_{pt} variables are treated as endogenous and instrumented using their 1971 values, plus the log of a population density measure (population in the province/km^2) dated 1921. The other variables are treated as endogenous and instrumented using their values lagged 3–6 both in levels and first differences (the sales growth variable uses instruments only in levels). TFP equations include year dummies; first-stage F-statistics of excluded instruments for GC_{gpt} and URB_{pt} equal, respectively, 18.9 and 33.3 in all instrumental-variable specifications. The GC_{gpt} and URB_{pt} variables are instrumented using the one-year lag of their growth between 1971 and current periods of observation, plus the one-year lag of the growth of population density between 1921 and current periods of observation. CC_{igpt} is the measure of credit constraints from the investment equations. The Kleibergen–Paap rk LM-statistic refers to the Kleibergen–Paap under-identification test of the instruments.

*$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.

require a longer time to develop in the absence of a common competence base among actors (MARTIN *et al.*, 2011). These results are robust to the estimation of the TFP equation in a reduced form, i.e. without controlling for firm-level and further local-level variables (see Appendix D in the supplemental data online for robustness results).

The credit constraints variable (i.e. the marginal effect of cash flow on investments obtained estimating the investment equation) shows negative and significant coefficients, thus suggesting a negative effect of credit rationing on productivity. However, the comparison of the coefficients of the credit constraints variable from Models (1) and (2) suggests a positive indirect effect of geographic concentration on the credit constraints–productivity relationship. Coefficients from Model (1) (where the investment equation is estimated without including the interaction term between cash flow and geographic concentration) are higher than the corresponding coefficients from Model (2) (where the investment equation is estimated accounting for the moderation effect of geographic concentration): geographic concentration seems to reduce the negative credit constraints–productivity relationship by about 4.5%.

A positive and significant relationship between firms' productivity and both size and wage also emerges, while the coefficients of the other control variables are never significant.

Table 2 reports results of the robustness exercise testing for the role of the local banking system. Diagnostic tests confirm the validity of the adopted estimation methodology for all specifications and, overall, previous results are confirmed.

Results of the investment equations show positive and significant coefficients of the cash flow variable, which provide evidence of credit rationing. The time-lagged dependent variable and the variable for firm size show positive and significant coefficients, while the TFP and age variables show negative and significant coefficients. The coefficients of the geographic concentration and operational proximity variables are not significant. The coefficient of the interaction term between cash flow and geographic concentration is negative and significant, thus confirming a positive moderation effect of geographic concentration on the investment-to-cash flow sensitivity.

The investment equation in Model (3) is estimated including a three-way interaction term between cash flow, geographic concentration and operational proximity. The estimated coefficient is negative and significant, even though it is slightly lower than the coefficient of the two-way interaction term estimated in Model (2). Fig. 1 provides a better understanding of this result. Fig. 1(a) plots the marginal effect of cash flow on investments at the minimum and maximum levels of geographic concentration when the operational proximity variable is kept at its minimum level, while the operational proximity variable is kept at its maximum

Table 2. Robustness exercise controlling for operational proximity

Model	(1)				(2)				(3)			
Dependent variable	$(I/Kb)_{igpt}$	TFP_{igpt}			$(I/Kb)_{igpt}$	TFP_{igpt}			$(I/Kb)_{igpt}$	TFP_{igpt}		
Estimation method	SYS-GMM	FE	FE-TSLS	FE-GMM	SYS-GMM	FE	FE-TSLS	FE-GMM	SYS-GMM	FE	FE-TSLS	FE-GMM
$(I/Kb)_{igpt-1}$	0.417***	…	…	…	0.415***	…	…	…	0.418***	…	…	…
	(0.035)				(0.035)				(0.035)			
$(CF/Kb)_{igpt}$	0.295***	…	…	…	0.257***	…	…	…	0.247***	…	…	…
	(0.043)				(0.064)				(0.065)			
$\Delta SALES_{igpt}$	0.046	…	…	…	0.053	…	…	…	0.048	…	…	…
	(0.040)				(0.040)				(0.041)			
GC_{gpt}	−0.011	0.219*	0.574**	0.547**	−0.057**	0.214*	0.569**	0.543**	−0.106**	0.214*	0.570**	0.543**
	(0.014)	(0.119)	(0.231)	(0.230)	(0.024)	(0.120)	(0.231)	(0.230)	(0.049)	(0.120)	(0.230)	(0.230)
URB_{pt}	…	−0.565	0.652	0.465	…	−0.559	0.688	0.498	…	−0.563	0.661	0.476
		(0.419)	(1.711)	(1.708)		(0.420)	(1.713)	(1.710)		(0.420)	(1.713)	(1.709)
OP_{pt}	0.003	…	…	…	0.002	…	…	…	0.045*	…	…	…
	(0.011)				(0.011)				(0.023)			
$(CF/Kb)_{igpt} \times GC_{gpt}$	…	…	…	…	−0.032*	…	…	…	…	…	…	…
					(0.017)							
$(CF/Kb)_{igpt} \times GC_{gpt} \times OP_{pt}$	…	…	…	…	…	…	…	…	−0.013*	…	…	…
									(0.007)			
CC_{igpt}	…	−0.138**	−0.138*	−0.139*	…	−0.137**	−0.137*	−0.138*	…	−0.120**	−0.120*	−0.123*
		(0.055)	(0.075)	(0.075)		(0.059)	(0.077)	(0.076)		(0.053)	(0.068)	(0.068)
TFP_{igpt}	−0.142**	…	…	…	−0.128*	…	…	…	−0.133*	…	…	…
	(0.068)				(0.069)				(0.074)			
$SIZE_{igpt}$	0.215***	0.091**	0.093**	0.093**	0.207***	0.091**	0.093**	0.093**	0.214***	0.090**	0.092**	0.092**
	(0.050)	(0.045)	(0.040)	(0.040)	(0.050)	(0.045)	(0.040)	(0.040)	(0.050)	(0.045)	(0.040)	(0.040)
AGE_{igpt}	−0.081***	−0.009	−0.023	−0.018	−0.076***	−0.008	−0.022	−0.018	−0.081***	−0.007	−0.021	−0.017
	(0.023)	(0.141)	(0.110)	(0.109)	(0.023)	(0.141)	(0.110)	(0.109)	(0.023)	(0.141)	(0.110)	(0.109)
$WAGE_{igpt}$	…	0.082*	0.085**	0.086**	…	0.082*	0.085**	0.086**	…	0.081*	0.084**	0.086**
		(0.048)	(0.043)	(0.043)		(0.048)	(0.043)	(0.043)		(0.048)	(0.043)	(0.043)
$VERTICAL_{igpt}$	…	−0.158	−0.146	−0.150	…	−0.154	−0.142	−0.147	…	−0.151	−0.138	−0.143
		(0.139)	(0.117)	(0.116)		(0.138)	(0.117)	(0.116)		(0.138)	(0.116)	(0.116)
$SALES_{igpt}$	…	0.003	0.004	0.003	…	0.004	0.004	0.004	…	0.003	0.003	0.003
		(0.003)	(0.004)	(0.004)		(0.003)	(0.004)	(0.004)		(0.003)	(0.004)	(0.004)
VA_{igpt}	…	0.484	−0.201	−0.079	…	0.480	−0.217	−0.093	…	0.480	−0.209	−0.088
		(0.576)	(0.901)	(0.898)		(0.576)	(0.903)	(0.900)		(0.574)	(0.902)	(0.899)
ΔVA_{igpt}	…	−0.587	−0.326	−0.393	…	−0.596	−0.330	−0.398	…	−0.595	−0.333	−0.400
		(0.513)	(0.640)	(0.638)		(0.514)	(0.641)	(0.638)		(0.514)	(0.641)	(0.639)
Number of observations	70 711	70 711	70 711	70 711	70 711	70 711	70 711	70 711	70 711	70 711	70 711	70 711
Number of firms	11 953	11 953	11 953	11 953	11 953	11 953	11 953	11 953	11 953	11 953	11 953	11 953
Number of instruments	193	…	…	…	194	…	…	…	194	…	…	…
AR(1) (p-value)	0.000	…	…	…	0.000	…	…	…	0.000	…	…	…

(*Continued*)

Table 2. Continued

Model	(1)				(2)				(3)			
Dependent variable	$(I/Kb)_{igpt}$	TFP_{igpt}			$(I/Kb)_{igpt}$	TFP_{igpt}			$(I/Kb)_{igpt}$	TFP_{igpt}		
Estimation method	SYS-GMM	FE	FE-TSLS	FE-GMM	SYS-GMM	FE	FE-TSLS	FE-GMM	SYS-GMM	FE	FE-TSLS	FE-GMM
AR(2) (*p*-value)	0.000	…	…	…	0.000	…	…	…	0.000	…	…	…
AR(3) (*p*-value)	0.501	…	…	…	0.561	…	…	…	0.522	…	…	…
Hansen *J*-statistic (*p*-value)	0.165	…	0.154	0.154	0.156	…	0.153	0.153	0.165	…	0.159	0.159
R^2	…	0.007	…	…	…	0.006	…	…	…	0.006	…	…
Kleibergen–Paap rk LM-statistic (*p*-value)	…	…	0.000	0.000	…	…	0.000	0.000	…	…	0.000	0.000
F-statistic on GC_{gpt} (*p*-value)	…	…	0.000	0.000	…	…	0.000	0.000	…	…	0.000	0.000
F-statistic on URB_{pt} (*p*-value)	…	…	0.000	0.000	…	…	0.000	0.000	…	…	0.000	0.000
Mean VIF	1.15	1.58	1.58	1.58	1.74	1.58	1.58	1.58	1.51	1.58	1.58	1.58

Notes: Bootstrapped standard errors are shown in parentheses and are clustered at province-industrial sector level (1291 units). Investment equations are estimated using a two-step system GMM estimator, with WINDMEIJER's (2005) correction; they include a constant term, industrial sector, NUTS-2 and year dummies. The dummy and age variables are used as instruments for themselves only in levels. The GC_{gpt} and URB_{pt} variables are treated as endogenous and instrumented using their 1971 values, plus the log of a population density measure (population in the province/km^2) dated 1921. The other variables are treated as endogenous and instrumented using their values lagged 3–6 both in levels and first differences (the sales growth variable uses instruments only in levels). TFP equations include year dummies; first-stage *F*-statistics of excluded instruments for GC_{gpt} and URB_{pt} equal, respectively, 18.9 and 33.3 in all instrumental-variable specifications. The GC_{gpt} and URB_{pt} variables are instrumented using the one-year lag of their growth between 1971 and current periods of observation, plus the one-year lag of the growth of population density between 1921 and current periods of observation. CC_{igpt} is the measure of credit constraints from the investment equations. The Kleibergen–Paap rk LM-statistic refers to the Kleibergen–Paap under-identification test of the instruments.

$^{*}p < 0.10$; $^{**}p < 0.05$; $^{***}p < 0.01$.

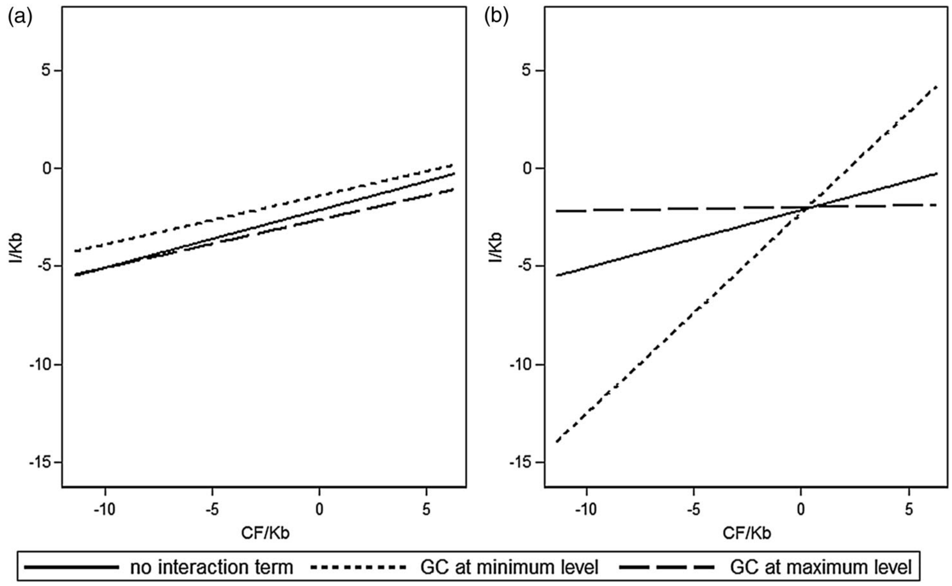

Fig. 1. Investment-to-cash flow sensitivity: three-way interaction
Note: Solid lines refer to Model (1), while dotted lines refer to Model (3) in Table 2. (a) Marginal effect of cash flow when the operational proximity variable is kept at its minimum level, while it is kept at its maximum level in (b)

level in Fig. 1(b). The comparison of the two panels suggests that the positive moderation effect of geographic concentration on the investment-to-cash flow sensitivity is increasing in the density of bank branches. This suggests a sort of complementary effect between geographic concentration and operational proximity. As the local density of bank branches increases, location in a highly agglomerated area favours inter-firm credit, for instance because firms can easily access to 'soft' information on (potential or new) business partners collected by their own local bank, or because higher competition in the local credit market allows firms to sign better contracts thanks to easier access to credit.

Results of the TFP equations highlight a positive and statistically significant relationship between localization externalities and productivity, while coefficients of the urbanization variable are never significant. Results confirm a positive and significant relationship between productivity and both size and wage, while coefficients of the other control variables are never significant. The coefficients of the credit constraints variable are negative and significant in all models. The estimated coefficient from Model (1) is slightly higher than the estimated coefficient from Model (2), thus suggesting little gain in terms of reduction of the negative credit constraints–productivity relationship favoured by geographic concentration when operational proximity enters the investment equation. However, the estimated credit constraints coefficient from Model (3) is highly lower than the estimated coefficient from Model (1). This last result confirms the previous finding of a complementary effect between geographic concentration and operational proximity: localization externalities positively moderate the negative credit constraints–productivity relationship, and this positive moderation effect increases as the density of bank branches increases in the local system.

CONCLUSIONS

This paper has put forth insights into the determinants of firms' productivity linking the literature on credit constraints to that on agglomeration economies. It has analysed whether Italian manufacturing firms' productivity is affected by credit rationing, while fostered by short-run localization externalities. Moreover, it has investigated whether localization economies moderate firms' investment-to-cash flow sensitivity promoting inter-firm trade credit, thus reducing the negative effect of credit rationing on productivity.

The analysis was conducted in three steps on a sample of 11 953 firms observed over the period 1999–2007. First, firms' TFP was estimated using the approach proposed by WOOLDRIDGE (2009). Second, a two-step system GMM estimator was employed to investigate whether Italian manufacturing firms are credit constrained, and whether localization economies positively moderate the investment-to-cash flow sensitivity. Third, instrumental-variable FE estimators were employed to analyse the credit constraints–productivity relationship, as well as the direct and indirect effect of localization economies on productivity.

Results suggest that firms are affected by credit constraints, and that geographic concentration positively moderates the investment-to-cash flow sensitivity promoting inter-firm trade credit. A positive relationship emerges between productivity and localization externalities, while urbanization externalities seem to have a negligible effect on productivity. Results suggest a negative relationship between credit constraints and productivity, while there is a positive indirect effect of geographic concentration on TFP: the negative effect of credit constraints on productivity decreases when the positive moderation effect of geographic concentration on the investment-to-cash flow sensitivity is accounted for, and this positive indirect effect of geographic concentration increases as the density of bank branches increases.

The fact that Italian manufacturing firms suffer from credit rationing may depend on the severity of the Italian banking system. This could also explain the relevance of inter-firm credit for firms that are unable to provide banks with the required warranties to obtain the credit necessary to finance new projects. Therefore, the importance of promoting inter-firm relationships and the formation of industrial conglomerates emerges, in particular in those areas where the financial system is less developed.

Acknowledgments – The author thanks Giulio Cainelli (University of Padova) and three anonymous referees for their valuable and constructive comments and suggestions.

Disclosure statement – No potential conflict of interest was reported by the author.

Supplemental data – Supplemental data for this article can be accessed at http://10.1080/00343404.2015.1064883.

NOTES

1. The 'omitted price bias', resulting from possible correlation between input choices and variation in the firm-level prices, characterizes both Levinsohn and Petrin's (2003) and Wooldridge's (2009) methodologies. Since firm-level prices are, in general, not observed, industry-level price indexes are used to deflate firms' balance sheet data. However, if firms have different market power, firm- and industry-level prices may differ and the use of industry-based deflators can lead to biased productivity estimates (Van Beveren, 2012).
2. Kaplan and Zingales (1997) and Chen and Chen (2012) provide evidence that investment-to-cash flow sensitivity does not represent a good measure of financing constraints. However, Alessandrini *et al.* (2009, p. 292) provide evidence on a sample of Italian manufacturing firms that 'rationed firms report a greater elasticity of investment with respect to cash flow than non-rationed ones'. Therefore, firms' investment-to-cash flow sensitivity can be considered a good proxy for credit constraints at least in the context of Italian firms.
3. The use of the Italian provinces to analyse agglomeration economies may lead to the modifiable areal unit problem (MAUP) since they are defined according to administrative criteria rather than to economic ones as the local labour markets (Arbia, 1989). However, data on Italian local labour markets are not available for the entire period analysed. Moreover, since provinces have policy powers concerning territorial planning, they may represent an appropriate territorial level to characterize firms' business environment (Cainelli *et al.*, 2015).
4. The variables URB_{pt} and OP_{pt} are not included together in the robustness exercise due to high correlation, i.e. 0.83.
5. Investment equations are estimated using the 'xtabond2' Stata routine (Roodman, 2009), while TFP equations are estimated using the 'xtivreg2' Stata routine (Schaffer, 2010).

REFERENCES

Ackerberg D. A., Caves K. and Frazer G. (2006) *Structural Identification of Production Functions*. Munich Personal RePEc Archive (MPRA) Paper No. 38349. University Library of Munich, Munich.

Aghion P., Angeletos G.-M., Banerjee A. and Manova K. (2010) Volatility and growth: credit constraints and the composition of investment, *Journal of Monetary Economics* **57**, 246–265. doi:10.1016/j.jmoneco.2010.02.005

Albareto G. and Finaldi Russo P. (2012) *Fragilità finanziaria e prospettive di crescita: Il razionamento del credito alle imprese durante la crisi*. Questioni di Economia e Finanza Occasional Paper No. 127. Bank of Italy, Rome.

Alessandrini P., Presbitero A. F. and Zazzaro A. (2009) Banks, distances and firms' financing constraints, *Review of Finance* **13**, 261–307. doi:10.1093/rof/rfn010

Arbia G. (1989) *Spatial Data Configuration in Statistical Analysis of Regional Economic and Related Problems*. Kluwer, London.

Arellano M. and Bond S. (1991) Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations, *Review of Economic Studies* **58**, 277–298. doi:10.2307/2297968

Arellano M. and Bover O. (1995) Another look at the instrumental variable estimation of error-components models, *Journal of Econometrics* **68**, 29–51. doi:10.1016/0304-4076(94)01642-D

Arrow K. J. (1962) The economic implications of learning by doing, *Review of Economic Studies* **29**, 155–173. doi:10.2307/2295952

Ayyagari M., Demirgüç-Kunt A. and Maksimovic V. (2007) *Firm Innovation in Emerging Markets*. Policy Research Working Paper No. 4157. The World Bank, Washington, DC.

Beaudry C. and Schiffauerova A. (2009) Who's right, Marshall or Jacobs? The localization versus urbanization debate, *Research Policy* **38**, 318–337. doi:10.1016/j.respol.2008.11.010

Blundell R. and Bond S. (1998) Initial conditions and moment restrictions in dynamic panel data models, *Journal of Econometrics* **87**, 115–143. doi:10.1016/S0304-4076(98)00009-8

Bond S. and Van Reenen J. (2007) Microeconometric models of investment and employment, in Heckman J. J. and Leamer E. E. (Eds) *Handbook of Econometrics, Vol. 6A*, pp. 4417–4498. Elsevier/North-Holland, Amsterdam.

Cainelli G., Ganau R. and Iacobucci D. (2015) Do geographic concentration and vertically-related variety foster firm productivity? Micro-evidence from Italy, *Growth and Change*. doi:10.1111/grow.12112

Cainelli G., Montresor S. and Vittucci Marzetti G. (2012) Production and financial linkages in inter-firm networks: structural variety, risk-sharing and resilience, *Journal of Evolutionary Economics* **22**, 711–734. doi:10.1007/s00191-012-0280-6

Cameron A. C. and Trivedi P. K. (2005) *Microeconometrics: Methods and Applications*. Cambridge University Press, New York, NY.

Carreira C. and Silva F. (2010) No deep pockets: some stylized empirical results on firms' financial constraints, *Journal of Economic Surveys* **24**, 731–753. doi:10.1111/j.1467-6419.2009.00619.x

Chen H. and Chen S. (2012) Investment-cash flow sensitivity cannot be a good measure of financial constraints: evidence from the time series, *Journal of Financial Economics* **103**, 393–410. doi:10.1016/j.jfineco.2011.08.009

Chen M. and Guariglia A. (2013) Internal financial constraints and firm productivity in China: do liquidity and export behavior make a difference?, *Journal of Comparative Economics* **41**, 1123–1140. doi:10.1016/j.jce.2013.05.003

Ciccone A. and Hall R. E. (1996) Productivity and the density of economic activity, *American Economic Review* **86**, 54–70.

Dei Ottati G. (1994) Trust, interlinking transactions and credit in the industrial district, *Cambridge Journal of Economics* **18**, 529–546.

Duranton G. and Puga D. (2004) Micro-foundations of urban agglomeration economies, in Henderson J. V. and Thisse J.-F. (Eds) *Handbook of Regional and Urban Economics, Vol. 4*, pp. 2064–2117. Elsevier, Amsterdam.

Fazzari S. M., Hubbard R. G. and Petersen B. C. (1988) Financing constraints and corporate investment, *Brookings Papers on Economic Activity* **1**, 141–195. doi:10.2307/2534426

Ferrando A. and Mulier K. (2013) Do firms use the trade credit channel to manage growth?, *Journal of Banking and Finance* **37**, 3035–3046. doi:10.1016/j.jbankfin.2013.02.013

Galuščák K. and Lízal L. (2011) *The Impact of Capital Measurement Error Correction on Firm-Level Production Function Estimation*. CNB Working Paper Series, Working Paper Number No. 9. Czech National Bank (CNB), Prague.

Gatti R. and Love I. (2008) Does access to credit improve productivity? Evidence from Bulgaria, *Economics of Transition* **16**, 445–465. doi:10.1111/j.1468-0351.2008.00328.x

Glaeser E. L., Kallal H. D., Scheinkman J. A. and Shleifer A. (1992) Growth in cities, *Journal of Political Economy* **100**, 1126–1152. doi:10.1086/261856

Graham D. J., Melo P. S., Jiwattanakulpaisarn P. and Noland R. B. (2010) Testing for causality between productivity and agglomeration economies, *Journal of Regional Science* **50**, 935–951. doi:10.1111/j.1467-9787.2010.00676.x

Guariglia A. (2008) Internal financial constraints, external financial constraints, and investment choice: evidence from a panel of UK firms, *Journal of Banking and Finance* **32**, 1795–1809. doi:10.1016/j.jbankfin.2007.12.008

Hansen L. P. (1982) Large sample properties of generalized method of moments estimators, *Econometrica* **50**, 1029–1054. doi:10.2307/1912775

Jacobs J. (1969) *The Economy of Cities*. Vintage, New York, NY.

Kaplan S. N. and Zingales L. (1997) Do investment-cash flow sensitivities provide useful measures of financing constraints?, *Quarterly Journal of Economics* **112**, 169–215. doi:10.1162/003355397555163

King R. G. and Levine R. (1993) Finance, entrepreneurship and growth: theory and evidence, *Journal of Monetary Economics* **32**, 513–542. doi:10.1016/0304-3932(93)90028-E

Kleibergen F. and Paap R. (2006) Generalized reduced rank tests using the singular value decomposition, *Journal of Econometrics* **133**, 97–126. doi:10.1016/j.jeconom.2005.02.011

Levinsohn J. and Petrin A. (2003) Estimating production functions using inputs to control for unobservables, *Review of Economic Studies* **70**, 317–341. doi:10.1111/1467-937X.00246

Love I. (2003) Financial development and financing constraints: international evidence from the structural investment model, *Review of Financial Studies* **16**, 765–791. doi:10.1093/rfs/hhg013

Marshall A. (1920) *Principles of Economics*. 8th Edn. Macmillan, London.

Martin P., Mayer T. and Mayneris F. (2011) Spatial concentration and plant-level productivity in France, *Journal of Urban Economics* **69**, 182–195. doi:10.1016/j.jue.2010.09.002

Melo P. C. and Graham D. J. (2009) *Agglomeration Economies and Labour Productivity: Evidence from Longitudinal Worker Data for GB's Travel-to-Work Areas*. SERC Discussion Paper No. 31. Spatial Economics Research Centre (SERC), London School of Economics and Political Science (LSE), London.

Melo P. C., Graham D. J. and Noland R. B. (2009) A meta-analysis of estimates of urban agglomeration economies, *Regional Science and Urban Economics* **39**, 332–342. doi:10.1016/j.regsciurbeco.2008.12.002

Menichini A. M. C. (2011) Inter-firm trade finance in times of crisis, *World Economy* **34**, 1788–1808. doi:10.1111/j.1467-9701.2011.01390.x

Neter J., Wasserman W. and Kutner M. H. (1985) *Applied Linear Statistical Models: Regression, Analysis of Variance, and Experimental Design*. Richard Irwin, Homewood, IL.

Nooteboom B. (2000) *Learning and Innovation in Organizations and Economies*. Oxford University Press, Oxford.

Petrin A. and Levinsohn J. (2012) Measuring aggregate productivity growth using plant-level data, *RAND Journal of Economics* **43**, 705–725. doi:10.1111/1756-2171.12005

Puga D. (2010) The magnitude and causes of agglomeration economies, *Journal of Regional Science* **50**, 203–219. doi:10.1111/j.1467-9787.2009.00657.x

Romer P. M. (1986) Increasing returns and long-run growth, *Journal of Political Economy* **94**, 1002–1037. doi:10.1086/261420

Roodman D. (2009) How to do xtabond2: an introduction to difference and system GMM in Stata, *Stata Journal* **9**, 86–136.

Rosenthal S. S. and Strange W. C. (2004) Evidence on the nature and sources of agglomeration economies, in Henderson J. V. and Thisse J.-F. (Eds) *Handbook of Regional and Urban Economics, Vol. 4*, pp. 2120–2171. Elsevier, Amsterdam.

Scalera D. and Zazzaro A. (2011) Do inter-firm networks make access to finance easier? Issues and empirical evidence, in Cafaggi F. (Ed.) *Contractual Networks, Inter-Firm Cooperation and Economic Growth*, pp. 39–65. Edward Elgar, Cheltenham.

Schaffer M. E. (2010) *xtivreg2: Stata Module to Perform Extended IV/2SLS, GMM and AC/HAC, LIML and k-class Regression for Panel Data Models* (available at: http://ideas.repec.org/c/boc/bocode/s456501.html).

Syverson C. (2011) What determines productivity?, *Journal of Economic Literature* **49**, 326–365. doi:10.1257/jel.49.2.326

Ughetto E. (2009) Industrial districts and financial constraints to innovation, *International Review of Applied Economics* **23**, 597–624. doi:10.1080/02692170903007599

Van Beveren I. (2012) Total factor productivity estimation: a practical review, *Journal of Economic Surveys* **26**, 98–128. doi:10.1111/j.1467-6419.2010.00631.x

Windmeijer F. (2005) A finite sample correction for the variance of linear efficient two-step GMM estimators, *Journal of Econometrics* **126**, 25–51. doi:10.1016/j.jeconom.2004.02.005

Wooldridge J. M. (2002) *Econometric Analysis of Cross Section and Panel Data*, 2nd Edn. MIT Press, Cambridge, MA.

Wooldridge J. M. (2009) On estimating firm-level production functions using proxy variables to control for unobservables, *Economics Letters* **104**, 112–114. doi:10.1016/j.econlet.2009.04.026