# Financial Constraints, Firms' Supply Chains and Internationalization

Raoul Minetti*
Michigan State University

Pierluigi Murro
Lumsa University

Zeno Rotondi
UniCredit

Susan Chun Zhu
Michigan State University

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**Abstract**

Using a unique, rich sample of Italian firms, we investigate the effects of firms' financial constraints on firms' participation in domestic and international supply chains. We find evidence that firms that are more exposed to credit rationing and have less stable relationships with their banks are more likely to seek affiliation with supply chains to overcome liquidity shortages. Firms appear to especially rely on supply chains as an alternative source of short-term liquidity (e.g., working capital funding) rather than for long-term investment funding. The benefits of supply chains as sources of liquidity turn out to be stronger when firms establish long-term relationships with large suppliers. To control for possible endogeneity of firms' access to credit, we construct instruments capturing exogenous shocks to the structure of the Italian banking system.

## 1 Introduction

The financial crisis started in 2008 has led to a large debate on the role of financial factors in shaping firms' domestic and international activities. By now, a large body of empirical literature has established that financial frictions have important effects on firms' production,

*Corresponding author. Email: minetti@msu.edu . Phone: +1-517-355-7349. Address: MSU Department of Economics, Marshall-Adams Hall, 486 W Circle Dr. Rm 110, East Lansing, MI 48824. We wish to thank several seminar and conference participants for helpful comments and conversations. All remaining errors are ours.

investment and export decisions. By contrast, perhaps because of a dearth of data, we still have very limited understanding on whether financial factors can also shape the organization itself of firms' production activities. The objective of this paper is to help shed light on this issue, focusing on a key dimension of the organization of production: firms' participation in domestic and international supply chains.

Firms' production is increasingly structured along domestic and global supply chains. A supply chain identifies the whole range of activities (design, production, distribution, and marketing) that businesses carry out to bring a product or a service from its initial conception to the final use by consumers (Gereffi and Fernandez-Stark, 2011).[1] The fragmentation of production can boost firm efficiency and competitiveness, allowing the different phases of production and marketing to be perfomed by the firms, and in the locations, with the strongest comparative advantage. It is now estimated that more than half of global manufactured imports consist of intermediate goods (primary goods, components, and semi-finished products), and more than 70% of world services imports consist of intermediate services.[2] And the average length of supply chains has significantly increased from the mid-nineties (see, e.g., De Backer and Miroudot, 2013).

Supply chains are not only an important mechanism for organizing production and exchange activities among firms, but may also constitute a crucial channel through which firms can borrow liquidity one from the other. In a supply chain, an upstream firm can finance a downstream firm through trade credit. In particular, a supplier (seller) can effectively extend credit to a buyer by allowing the latter to purchase goods with a delayed payment. The delayed payment will appear as accounts receivable on the seller's balance sheet and as accounts payable on the buyer's balance sheet. In this way, accounts receivable and payable form a chain of claims and obligations within a supply chain.[3]

The objective of this paper is to help shed light on whether firms' access to credit markets is a determinant of their choice to participate in supply chains. If so, what type of financial factors (e.g., strength and length of bank-firm relationships) especially drive this choice? And what characteristics of supply chains and suppliers do liquidity-constrained firms seek when deciding whether to join a supply chain? Using a unique, rich sample of Italian firms, we investigate the effects of firms' financial constraints on firms' participation in domestic and international supply chains. The survey data we use are an ideal testing ground for

[1] Services are also produced in supply chains. The rise of business process offshoring is an example.

[2] The rise of global value chains has been a salient aspect of the world economy in recent years (Miroudot et al., 2009). Businesses from developing countries, especially East Asia, have been a major player in global value chains (World Bank, 2003).

[3] The use of trade credit in supply chains is also useful to mitigate the effects of demand uncertainty. In fact, the timing of trade credit is tightly related to purchase decisions, whereas its repayment depends on the realization of demand. Yang and Birge (2010) also suggest that trade credit can be used as a risk-sharing mechanism. Often, bank credit is senior to trade credit. When a debtor cannot repay all his debt, the trade creditor will not receive payments until bank debt is repaid.

our purposes, because they provide rich information on firms' affiliation to supply chains, the nature of suppliers and buyers in supply chains, as well as other rich details on supply chains. The survey also asks firms several precise questions about their access to credit markets, including whether firms are credit rationed, and the strength (number and length) of their credit relationships with banks. We find evidence that firms that are more exposed to credit rationing and have less stable (shorter and more fragmented) relationships with banks are more likely to participate in supply chains to overcome liquidity shortages. Firms appear to especially rely on supply chains as an alternative source of short-term liquidity (e.g., working capital funding) rather than for long-term investment funding. In addition, the benefits of supply chains as sources of liquidity turn out to be stronger when firms establish long-term relationships with large suppliers. Overall, our results thus indicate that supply chains effectively act as a substitute source of external finance for firms that face difficulties in accessing financial markets.

The reader could be concerned that the estimated effects of credit rationing and credit relationships on firms' participation in supply chains suffer from endogeneity problems. That is, although we control for a battery of relevant characteristics of firms and their local environment, unobserved factors could drive both firms' financial status and their participation in supply chains. And reverse causality problems could also be an issue as the participation in supply chains might send a signal to creditors, facilitating the extension of credit. To control for possible endogeneity of firms' access to credit and firms' relationships with banks, we then construct instruments capturing exogenous shocks to the structure of the Italian banking system. For this purpose, we exploit the merger among four Italian banks occurred in 2007, using measures of the relative presence of the merged banks in the local (provincial) credit market as a proxy for the intensity of the merger shock on firms' access to credit and firms-banks' relationships.

The remainder of the paper unfolds as follows. In Section 2, we provide details on the institutional background, including information on the participation in supply chains by Italian firms as well as characteristics of the Italian financial system. Section 3 discusses the key theoretical predictions. Section 4 describes empirical methodology, data, and measurement of the variables. Section 5 presents the main results, while Section 6 focuses on robustness checks. Section 7 concludes.

## 2 Prior Literature

There is a large theoretical literature on the importance of trade credit as a source of external financing, in spite of the fact that trade credit is notoriously an expensive form of finance (see, e.g., Ng, Smith and Smith, 1999). The extant theories suggest that firms increase their demand for trade credit when they are subject to credit rationing (see, e.g.,

Biais and Gollier, 1997; Burkart and Ellingsen, 2004). Wilner (2000) shows that firms with a larger probability of default are more willing to pay the higher cost associated with trade credit because renegotiation concessions are more likely. Cunat (2007) shows that suppliers provide liquidity to customers that experience temporary liquidity shock. The idea behind these models is that, when liquidity is scarce, cash-rich suppliers have a lower opportunity cost of funds. Thus, they are able to offer liquidity insurance increasing the volume of trade credit provided to their constrained clients. There is an established empirical literature on the relevance of trade credit as a source of external financing (see, e.g., Petersen and Rajan, 1997; Burkart, Ellingsen and Giannetti, 2011). Rajan and Zingales (1995) find that in a sample of U.S. nonfinancial firms, trade credit accounts for 15 percent of firms' assets. The Financial Times estimated that in 2007 90% of world trade was financed by trade credit. And Yang and Birge (2013) obtain that in a sample of retailers in North America, accounts payable amount to roughly one sixth of total assets and one third of total liabilities. The observed behavior of supply chains during the recent financial crisis can also hint at the importance of trade credit in supply chains. During the crisis, in fact, several commentators pointed at a decrease in the length of supply chains, and a tendency of the domestic part of supply chains to increase relative to the foreign component (suggesting some form of substitution of foreign suppliers with domestic suppliers in periods of tight credit). Garcia-Appendini and Montoriol-Garriga (2013) exploit the unexpected credit supply shock occurred during the 2007-2008 financial crisis and study the impact of the crisis on trade credit flows. They find that firms with high pre-crisis liquidity levels increase the trade credit extended to other corporations experiencing better performance relative to ex ante cash-poor firms.

This paper also relates to the growing literature on global value chains. A broad body of literature has investigated theoretically how global value chains may affect the volume and pattern of international trade (see, e.g., Yi, 2003; Grossman and Rossi-Hansberg, 2008). The international fragmentation of production is viewed as a source of increased efficiency and firm competitiveness. Antras and Chor (2013) develop a model to study how the sequentiality of production affects the contractual relationships among final-good producers and suppliers. From an empirical viewpoint, we still have little hard evidence on the determinants of firms' decisions to join supply chains. Most papers are based on case studies or focus on specific industries (see, e.g., Gereffi, 1999; Fernandez-Stark, Bamber and Gereffi, 2011; Sturgeon and Kawakami, 2010; Kannegiesser, 2008). Alfaro, Antras, Chor and Conconi (2015) study the determinants of a firm's propensity to integrate upstream versus downstream inputs and find that the elasticity of demand faced by parent firms influences the average upstreamness upstreamness and of its integrated inputs. Baldin and Lopez-Gonzales (2014) examine the global picture of the cross-border flows of intermediate goods and services. Giovannetti, Marvasi and Sanfilippo (2015) show a positive relation between

the probability of internationalization and firms' involvement in supply-chains.

# 3 Institutional Background

According to census data from ISTAT (the Italian National Statistics Office), the Italian production system is characterized by close working relationships among firms, with 63,3% (660,000) of the firms having at least one stable informal or formal partnership agreement. The intensity of these relationships increases with firm size and is higher in the manufacturing sector (with the highest average firm size, 18.4 employees) and the construction sector (with the lowest average firm size, 8 employees). Among firms with partnership agreements, job orders involve 74,1% of firms and are distributed homogeneously among size classes, while subcontracting involves 56,6% of firms and is more frequent for small- and medium-sized firms (64%). By contrast, informal agreements are relative infrequent, involving 15,6% of the firms with partnership agreements, especially micro- and small-sized enterprises (16,7%).

In recent years, in Italy the role of supply chains and global value chains has been increasing. Firms can choose to operate only in intermediate segments of the supply chain by processing and assembling imported inputs, before re-exporting to final producers and retailers abroad. Accetturo et al. (2013) find that the share of total turnover made up by sales of produced-to-order goods to foreign firms is higher in Italy and France (more than 40%) than in Germany and Spain (23%).[4] During the recent financial crisis, Italian supply chains exhibited a pronounced reduction in their turnover, in all the phases of the supply chain. In 2009 the turnover was less than 80% of the turnover of 2007 (except for the firms producing final goods and for the firms operating in the distribution segment).

From an aggregate perspective, indicators of international fragmentation of production show that the participation of Italian firms in global value chains is relatively high in comparison with countries with similar level of economic development and industrial structure. Considering the manufacturing sector only, Breda and Cappariello (2012) show that in Italy and Germany the import content of production is similar and in 2007 amounted to around 30%, despite the higher share of low-tech sectors in Italy (traditionally, the least internationally fragmented). Cappariello and Felettigh (2015) show that in 2011 in Italy, Germany, France and Spain almost 40% of gross exports involved the participation in global value chains. Italy is the country for which the foreign content of exports started at the lowest level and grew at the fastest pace since 1999. Amador, Cappariello and Stehrer (2014) find that in the euro area, eliminating intra-euro area trade flows, in 2011 the main contributors

[4] However, Accetturo and Giunta (2014) argue that the positioning of the Italian firms along GVCs is not particularly favorable in comparison with German firms.

to the area's foreign content of gross exports were Germany (36,4%), France (14,4%) and Italy (12,7%).

Turning to the characteristics of the Italian financial system, this can be described as a bank-based system. The capitalization of the Italian stock market is relatively low compared to other advanced economies (according to data from the World Bank, 2012, in 2010 the ratio between the stock market capitalization and the GDP was 15.4%, compared with 117.5% in the United States). In this context, the external financing of firms mainly occurs through banks. The central role of banks in the financing of businesses makes the Italian financial system close to that of other countries of continental Europe, such as France and Germany, and to Japan. A second important feature of the Italian banking system is its delimitation within local areas. These areas roughly coincide with Italian provinces (Sapienza, 2002; Guiso, Sapienza and Zingales, 2003), local entities defined by the Italian law that are similar in size to U.S. counties. There were many regulatory restrictions on lending and branching in provinces until the early nineties, thus firms' access to credit is still highly heterogeneous across provinces. Between 1936 and 1985, in Italy the number of bank branches grew by 87% versus 1228% in the United States. By contrast, between the end of the 1980s and the late 1990s, that is, after the deregulation, it grew by about 80%, almost double than in the United States. In Italy, a large presence of local bank branches is crucial for firms' access to credit since distance matters in the collection and provision of funds (Petersen and Rajan, 2002; Guiso, Sapienza and Zingales, 2004) and for firms it is particularly difficult to deposit or borrow in a market other than the local (provincial) one. Indeed, distant lenders face pronounced informational disadvantages that can lead to a higher loan default rate for banks entering new markets without having a branch on site (Bofondi and Gobbi, 2006).

# 4 Theoretical Predictions

Supply chains can constitute a key channel through which firms can satisfy their liquidity needs. We thus expect that firms more exposed to financial frictions are more inclined to participate in supply chains.

Hypothesis 1. Firms more exposed to credit rationing, and with less stable (e.g., shorter and more fragmented) relationships with banks, participate more in supply chains to broaden their sources of liquidity.

The reliance on supply chains as a source of liquidity is likely to be more instrumental to the provision of funds for a firm when its suppliers are less liquidity constrained and, to some extent, when its buyers also need less funds.

Hypothesis 2. Firms are more likely to resort to supply chains as a source of liquidity

when their suppliers and buyers are larger and forge longer-term relationships, respectively with downstream and upstream firms within supply chains.

As noted, trade credit provided within supply chains is especially useful for responding to short-term liquidity needs. This leads to the third hypothesis.

Hypothesis 3. Firms more exposed to credit rationing, and with less stable credit relationships, are more likely to participate in supply chains when they need financing for working capital (rather than for long-term investment financing).

In what follows, we test these and further ancillary hypotheses by exploting rich survey data from Italy.

# 5 Data and Empirical Strategy

In this section, we discuss the empirical methodology, the data used in the analysis, and the measurement of the variables.

## 5.1 Empirical Model

We study how firms' access to credit may influence firms' decision to participate in a supply chain. The probability that firm $i$ participates in a supply chain can be written as

$$\mathrm{P}(SupplyChain_i = 1|R_i, Z_i) = \Phi\left(\alpha_1 + R_i\beta_1 + Z_i\gamma_1\right), \tag{1}$$

where $\Phi(\cdot)$ is the standard normal cdf, $R_i$ measures firm $i$'s access to credit (e.g., whether the firm is credit rationed or not, and the strength of credit relationships as proxied by the number of banks from which the firm borrows and by the length of the bank-firm relationships); and $Z_i$ is a vector of controls for firm characteristics that may affect firm $i$'s supply chain decision, as well as controls for regional differences. In the empirical analysis, we also adopt a linear probability model to characterize the supply chain participation decision as follows:

$$\mathrm{P}(SupplyChain_i = 1|R_i, Z_i) = \alpha_1' + R_i\beta_1' + Z_i\gamma_1'. \tag{2}$$

One might be concerned that a firm's access to credit may be endogenous. It is possible that some omitted variable could be correlated with a firm's access to credit and also affect a firm's decision to participate in supply chains. Note that our empirical specification controls for a rich set of factors that may affect supply chain decisions, including firm-level characteristics and region fixed effects. This should minimize the risk of omitting factors correlated with both credit access and supply chain decisions. However, it remains

possible that there exist unobserved factors that simultaneously affect credit access and supply chain decisions. To assuage this concern, we complement OLS and Probit estimates with an instrumental variable approach.

We aim at capturing exogenous shocks to the structure of the Italian local (provincial) credit markets which could have affected firms' access to credit as well as firms' incentives and ability to establish credit relationships with banks. For this purpose, we exploit the merger among four Italian banks occurred during 2007. While the banks involved in the merger operated in all the Italian territory, their presence differed quite significantly across provinces at the time of the merger. We then expect that the actual impact of the merger on firms' access to credit depended on the relative importance of the merged banks relative to other banks in the local (provincial) market at the time of the merger. For instance, in a province with a larger share of branches of the merged banks, firms should have benefited from increasing economies to scale more than in a province with a scarce presence of the merged banks.

For our instruments to be valid, they must be correlated with our proxies for credit rationing and credit relationships, while they must not be correlated with unobservable variables (economic and institutional features of the provinces) which could also correlate with firms' decision to join supply chains. Regarding the first aspect, two elements are worth mentioning. First, Italian firms strongly rely on banks for obtaining external funds, as discussed above. This is even more true for the firms in our sample which are small and medium-sized and, thus, have very limited alternative sources of funds. Second, the relevant credit market for Italian firms is the provincial one, also as a result of the historical evolution of the Italian local credit markets which remained segmented for several decades due to the banking regulation introduced in the 1930s.

We have strong reasons to believe that at the time of the merger the relative presence of the four banks in the provinces was not correlated with systematic economic features of the provinces themselves. In fact, this presence was the result of the historical evolution of the banking sector in the decades during which the 1936 banking regulation was in place, as well as the historical presence of the banks in the geographical areas, due to ties to the local communities and the geographical roots of the banks. For example, the Bank of Sicily was particularly strong in Sicily and in neighboring southern regions because of the traditional vocation of the bank in serving Sicilian provinces, due to its origins and its close ties to those geographical areas.

In practice, as instruments we use the share of branches of the banks involved in the merger, relative to the total number of branches in the province, and the difference between the share of branches of the two main banks involved in the merger, Unicredit and Capitalia. The latter variable can capture possible difficulties in the implementation of the merger due to significant asymmetries in the local importance of the banks involved. We expect that

the probability of credit rationing is negatively correlated with the share of branches of the merged banks in the province. We also experiment with alternative instrumental variables, such as the change in the share of branches of the banks involved in the merger between 2007 and 2008.

### 5.2 Data

Our main data source is the VIII UniCredit Survey on small and medium-sized enterprises (SMEs), a survey carried out by the Italian banking group UniCredit in 2011 on the previous year 2010. Every year this survey gathers data on a sample of Italian firms that are customers of the bank. The 2011 wave consists of 6,025 small firms and 1,408 medium-sized firms. The sample is representative of the referred bank's portfolio, whose composition is well diversified by sector, given the large dimension of the bank in terms of loans, deposits and branches. The survey was designed according to a stratified selection procedure, so that findings are representative at company size level, individual sector level (where the sectors considered are Agriculture, Manufacturing, Services, Trade and Construction), as well as at the territorial level (province).

The main strength of this survey is its very detailed information on individual firms. In particular, the 2011 wave comprises information on the firm's: a) partnerships with other firms and whether it is part of a district or a global value chain; b) financial structure and relationships with the banking system; c) extent of internationalization and exports; d) ownership/organizational structure and number of employees; e) propensity to innovate.

Table 1 reports the summary statistics for the variables included in our regressions. The geographic distribution of the firms reveals a prominence of the North of Italy (57% of the total), while other firms are based in the Center (19%), South and Islands (24%). By construction of the sample, the average dimension of the firms, measured by the number of the employees, is relatively small (15.38). Only 26% of the firms in the sample are corporations. The sector composition is affected by the nature of the sample. In fact, small firms usually dominate in sectors such as commerce (28% of the firms in the sample) and services (30%) compared to large firms. Manufacturing firms are 26% of the total, while Construction represents 10% of the sample. Finally, in the sample there are firms in tourism (2.7%) and agriculture (1.9%) sectors. In general, however, the composition is representative for both sample size and shares of the underlying population, so that sector peculiarities should not affect our analyses.

To complement the survey, we employ data made available by the Bank of Italy on the presence of banks in local markets. We also use data from the Italian National Statistics Office (ISTAT) on the population of provinces.

### 5.3 Measurement

#### 5.3.1 Supply chain and subcontracting

The survey asks each firm to report details on its participation in supply chains. In particular, the firms are requested to report if they are part of a supply chain, and, if so, at which level. In our sample, 52.8 percent of the firms participate in a supply chain. In particular, 16.2 percent of the firms are in an upstream position (that is, purchase raw materials and produce an intermediate good), 10.2 percent are in the middle (that is, use and produce semi-finished intermediate goods), and 26.4 percent are at the end of the supply chain (that is, use semi-finished intermediate goods and produce final goods).

A second aspect that the survey explores is whether the firms produce or buy in subcontracting. In our sample, 10.8 percent of the firms produce or buy in subcontracting. In particular, 5.8 percent of the firms are subcontractors of a foreign firm, and 1.3 percent of the firms are subcontractors only for domestic firms.

#### 5.3.2 External financial variables

We consider three main measures of lending conditions: credit rationing, the number of relationships with banks and the duration of the relationship with the main bank. Our measure of credit rationing is based on firms' response to the following question in the survey: "In 2010, would the firm have liked to obtain more credit at the market interest rate?". This measure is a dummy variable that treats as rationed the firms that responded "yes" to this question. As shown in Table 1, 37.6 percent of the firms in the sample are credit rationed. This figure for rationing is larger than those obtained by papers that study the rationing of firms in Italy. For example, considering the EFIGE survey for the year 2009, Ferri and Murro (2015) find that about 12.6% of Italian manufacturing firms were denied credit. Bank of Italy (2011) finds that the percentage of rationed firms in 2011 was equal to 12%. A likely explanation for our somewhat higher figure is that the firms in our sample are small (with an average of 15 employees for firm). In fact, Albareto and Finaldi Russo (2012) estimate that the percentage of rationed firms in Italy is significanty higher for firms with fewer than 50 employees.

Next, we construct alternative measures of credit conditions using further information in the survey. The survey asks each firm to indicate the number of banks from which it borrowed. Nearly 41% of the firms have only one bank, the mean number of banks is 2.4 and the median is 2. Multiple credit relationships can dilute the importance of the relationship with the main bank, thus exacerbating informational asymmetries and the probability of credit rationing (Petersen and Rajan, 1994).[5] Finally, we also use, as a

[5] However, multiple relationships could have some benefit in providing firms with some form of insurance

proxy for the strength of credit ties, the length of the relationship with the firm's main bank, measured by the number of years the firm has been operating with its current main bank. The literature finds evidence that long-term relationships promote better information acquisition and monitoring by banks and, hence, increase credit availability (Petersen and Rajan, 1994, 1995). This implies that a longer credit relationship with the main bank is likely to reduce the probability that the firm faces credit rationing. In our sample, the duration of the main credit relationship is 13.5 years on average. This figure is in the ballpark of what found by other studies on Italian firms (see, e.g., Herrera and Minetti, 2007).

### 5.3.3 Instruments

In May 2007, UniCredit bought Capitalia for more than $29 billion in shares to create a larger bank, with branches stretching from Sicily to Eastern Europe. The merger cemented UniCredit's position as Italy's largest bank by market value. The takeover enabled the new UniCredit to achieve a combined market capitalization of more than $135 billion. The entity resulting from the merger benefited from geographically diversified operations across four core markets (Italy, with 16% of market share; Germany, with 5% of market share; Austria with 19% of market share; and CEE with a presence in 17 countries - twice the next bank in terms of assets in the region). The group resulting from the merger adopted a business model consistent with the previous divisional structure of UniCredit, with a focus on customer segmentation (retail, private and corporate). In general, Capitalia's activities were integrated within the existing UniCredit Divisions. During the years 2008-2009, retail banking services in Italy were offered through three entities (UniCredit Banca, Banca di Roma, Banco di Sicilia) in order to maximise commercial effectiveness and to leverage on highly recognised brands and expertise that benefited from strong local roots. This goal was pursued through an intragroup branch transfer conducted in accordance with the specific regional responsibilities (i.e., UniCredit Banca in Northern-Italy, Banca di Roma in the Centre-South, and Banco di Sicilia in Sicily) and through the integration of Bipop-Carire into UniCredit Banca.

As instruments we use the share of branches of the banks involved in the 2007 merger, relative to the total number of branches in the province, and the difference between the share of branches of the two bank groups involved in the merger, UniCredit and Capitalia. The latter variable can capture possible difficulties in the implementation of the merger due to significant asymmetries in the local importance of the banks involved. We also experiment with alternative instrumental variables, such as the change in the share of branches of the banks involved in the merger between 2007 and 2008. As we shall see, in the first stage

against shocks to the financial status of their main bank (Detragiache, Garella and Guiso, 2000).

regressions we obtain evidence that the higher the share of branches of the merged banks in the province, the smaller the probability of credit rationing. This indicates that the merger favored borrowers when the banks involved accounted for a larger portion of the local banking market, for example because the merger allowed to better exploit economies to scale or better share information among bank branches (which previously was segmented across the banks).

#### 5.3.4 Control Variables

We include a comprehensive range of explanatory variables as controls in the regressions. To account for the fact that larger and older firms are less likely to participate in a supply chain, we include firm size, measured as the log of total employees, and age (years from a firm's inception). We also include dummy variables indicating whether a firm is a corporation, and whether it belongs to a partnership. In addition, we include industry dummy variables to account for other sources of comparative advantage and for the pattern of global demand for goods. We further control for heterogenous local socio-economic conditions in the province by inserting area dummies indicating whether a firm is headquartered in the South or Center of Italy. In fact, the main geographical areas of Italy differ substantially in infrastructure and institutions. Finally, we control for the provincial bank branch density to capture the degree of banking (financial) development in the province.

## 6 Supply Chain Participation

In this section, we investigate the relationship between a firm's access to credit and its participation in supply chains.

### 6.1 Baseline results

Table 2 lists the baseline results. In columns 1-4, a firm's ability to access credit is captured by a dummy variable indicating whether the firm is credit rationed or not. Column 1 shows the OLS estimates. The coefficient on credit rationing suggests that a credit rationed firm is 4.6 percentage points more likely than non-rationed firms to participate in a supply chain. This magnitude is not small considering that 48% of the firms are part of supply chains. Column 3 reports the marginal effects from a probit. The result for credit rationing is very close to the OLS estimate.

In columns 2 and 4, we treat credit rationing as endogenous and instrument for it using the share of branches of the banks involved in the bank merger, and the difference between the share of branches of the two main banks involved in the merger, Unicredit and Capitalia. We estimate the effect of credit rationing on the probability of participating in a supply

chain using two different approaches. In column 2, we use two-stage least squares (2SLS) estimation. In column 4, we use bivariate probit estimation since both supply chain decisions and credit rationing are binary variables. As shown in columns 2 and 4, after instrumenting for credit rationing, we find an even larger positive coefficient on credit rationing. (Note that in column 4 we report the marginal effects). Thus, the OLS results are confirmed by the IV estimates of the effect of credit rationing on the probability of participating in a supply chain.

The first-stage results for the intruments are reported at the bottom of the table. We find that the higher the share of branches of the merged banks in the province, the smaller is the probability of credit rationing. This indicates that the merger favored borrowers when the banks accounted for a larger portion of the local banking market, for example because the merger allowed to exploit economies to scale, or better share information among bank branches.

The banking literature stresses that the strength of credit relatonships can complement measures of credit rationing in measuring firms' access to credit. In columns 5-6, we measure the strength of firms' relationships with banks using the number of banks from which a firm borrows. Firms with more banks are considered to have a less stable relationship with the main bank, which could imply a larger probability of financial tension. Although the OLS estimates in column 5 do not indicate a significant relationship between the number of banks and the probability of participating in a supply chain, the 2SLS estimates in column 6 suggest that firms that have relationships with more banks are also more likely to participate in a supply chain. This result is consistent with the results shown in columns 1-4, suggesting that firms with weaker (more fragmented) credit relatonships may rely on supply chains as a further source of liquidity.

In columns 7-8 firms' access to credit is captured by the length of the relationship with the main bank. A longer bank-firm relationship indicates a more stable relationship, which could imply a smaller probability of credit constraints. Unlike the OLS results in column 7, the 2SLS estimates shown in column 8 suggest that firms with a longer relationship with their main bank are less likely to join a supply chain. This result is thus consistent with those obtained using credit rationing and number of banks to capture the access to credit. Overall, the consistency in the inferences drawn from using the three alternative measures of access to credit is particularly reassuring.

In the estimation, we also control for various firm characteristics. We find that younger firms are more likely to be part of a supply chain. Being part of a supply chain could help a firm to grow. We further find that smaller firms are more likey to participate in supply chains. This could stem from the fact that larger firms integrate some operations within the firm boundary. Firms with partnership are less likely to join a supply chain. There is also a significant difference across regions. Firms located in the Center or South are significantly

less likely to participate in supply chains compared to firms located in the North.

Table 3 reports additional robustness checks on the main results. To save space, we only report the IV estimates. In columns 1-4 we add an additional variable (the share of branches of the two main local banks in 2007) to control for the degree of concentration of the local banking market. The results suggest that this measure has no significant effect on the supply chain decision and the estimated coefficients on credit rationing and the measures of the strength of credit relationships remain unaltered. In columns 5-8 we add an additional instrument, the change between 2007 and 2008 in the share of provincial branches of the five largest banks in the province. This share might have been significantly affected by the merger between Unicredit and Capitalia. This additional instrument is weakly and negatively correlated with credit rationing, but not with measures of the strength of credit relationships. The results show that including this additional instrument causes little change in the estimated coefficients on credit rationing, the number of banks, or the length of the main credit relationship.

In columns 9-14 we carry out placebo tests. Instead of using the share of branches of the banks involved in the bank merger, and the difference between the share of branches of the two main banks, as instruments for firms' credit conditions, we use the share of provincial branches of Intesa San Paolo or the share of Monte dei Paschi di Siena (MPS). These two measures are unrelated to the 2007 bank merger. As shown at the bottom of columns 9-14, these two measures are not significantly correlated with credit rationing or with the measures of the intensity of credit relationships. This result provides additional evidence that the cross-firm variation in credit conditions is likely a result of the 2007 merger. Further, since the two measures are not strongly correlated with firm credit conditions, the second stage estimates are not statistically significant.

Overall, the results reported in Tables 2 and 3 suggest that firms with more difficult access to credit are significantly more likely to participate in a supply chain. In the next sections, we are going to further investigate this point.

### 6.2 Characteristics of partners, banks, and linkages

If the propensity of participating in a supply chain is (partly) driven by the lack of credit, the characteristics of the partners with which the firm is collaborating could matter in the relationship. Larger businesses have allegedly easier access to financial markets because more public information is available about them (e.g., they are better covered by the financial press and by financial analysists). In addition, a longer relationship between two firms will also allow the firms to acquire more information about each other. We then expect that larger partners and partners with longer relationships are better able to help overcome the possible shortage of liquidity along the supply chain. Similarly, if the firm's buyers are larger and have longer relationships with the firm, the firm could not need to use its internal

liquidity to fund its customers. To probe this point, we exploit the information available in our survey on the size of partners and the length of the firm-partner relationship. We distinguish partners into two types: those from which a firm acquires its inputs (i.e., the partner is upstream in the supply chain), and those to which a firm sells its inputs (the partner is downstream in the supply chain).

In columns 1-4 in Panel A of Table 4, the dependent variable is a dummy that equals one if the partner is large and supplies inputs, and zero otherwise. In columns 5-8, the dependent variable is a dummy that equals one if the partner is large and acquires inputs, and zero otherwise. The results in Panel A suggest that credit rationed firms are more likely to participate in a supply chain with large partners than with medium- or small-sized partners, indicating that large partners might be more likely a source of credit than medium or small-sized partners. In addition, the results appear to be stronger when the firm is upstream and its partner is downstream in the supply chain.

In columns 1-4 of Panel B, the dependent variable is a dummy that equals one if the firm has a long-term relationship with its input suppliers, and zero otherwise. In columns 5-8, the dependent variable is a dummy that equals one if the firm has a long-term relationsip with its input acquirers, and zero otherwise. Both OLS and probit estimates suggest that credit rationed firms are significantly more likely to have a long-term relationship with its partners than non-rationed firms, which suggest that a stable long-term relationship along the supply chain could make it easier for firms to obtain liquidity from their partners along the supply chain.

Next, we focus on the characteristics of the main bank from which a firm borrows. Banks may or may not attribute importance to a firm's collaboration with other companies, e.g., joining a supply chain. One could suspect thst the true that induces a finsancially constrained firm to join a supply chain is that tjis affiliations acts as a signal for banks, and not because the supplychain is effectively a source of liquidity. If this was the case we would expect that if the main bank does not consider collaborations among firms as important, firms are more likely to rely on their partners in the supply chain as a source of liquidity. In Table 6, the OLS estimates and the probit estimates show a strong positive coefficient on credit rationing. However, we find no significant effect of credit rationing on the likelihood of joining a supply chain after accounting for endogeneity of credit rationing. We also find no strong results when using the number of banks or the length of firm-bank relationships.

Finally, we investigate how the results differ depending on the tightness of the links among firms belonging to the supply chain. Ex ante, there are two possible effects. On the one hand, in supply chains featuring tighter links suppliers could more inclined to provide financing to their customers, for example they can accumulate better information on them or simply because they can more easily enforce repayments of debt obligations. on the other hand, one could argue that if links among firms are strong for technological reasons,

financial considerations could be less relevant in driving firms' decisions to stay in supply chains. we perform two kinds of tests on this point. first we use information on whether the supplier is also the principal partner in innovative projects, which is likely to indicate tighter links. We obtain evidence that credit rationed firms are ,ore likely to be affiliate to supply chains when this is the case , suggesting that tighter links favor the extension of credit within the supply chain. second we use information of autonomy of firms in supply chains. in this case, however we do detect significant =differences in the effect of financial constrains across different degrees of autonomy.

# 7 Further tests

In this section, we perform a broad range of robustness tests aimed at disentangling the mechanisms through which financial constraints can affect firms' participation in supply chains.

## 7.1 Working capital or investments?

Kalemli-Ozcan, Kim, Shin, Sorensen and Yesiltas (2013), Kim and Shin (2012), and Kim and Shin (2013) argue that working capital (accounts receivable and payable) helps bind firms together in a production chain because working capital can provide financial sources to fill the gap between the point when a production cost is incurred and the point when cash flow materializes. We are now going to examine whether this hypothesis holds in our data. Our survey provides information on the most important factors leading to a change in the application for credit lines and loans, including credit needs for inventories and working capital, and credit needs for fixed investments. In Table 4 we study how the relationship between credit rationing and the likelihood of participating in supply chains varies across firms with different credit needs. As shown in columns 1-4, the coefficients on credit rationing are positive when firms and working capital are all positive, and the coefficient is significantly positive in column 4 when we account for the endogeneity of credit rationing and for the fact that credit rationing is a binary variable. These results suggest that credit rationed firms with needs for working capital funding are more likely to be part of supply chains. By contrast, the estimated coefficients on credit needs for working capital are all negative in columns 1-4, suggesting that non-rationed firms with credit needs for working capital are less likely to join supply chains. Thus, participation in a supply chain might potentially alleviate the negative impact of credit rationing on firms when the needs for funding of working capital are important.

The results on credit for fixed investments are mixed. The OLS and probit estimates in columns 5 and 7 suggest a weakly positive interaction between credit rationing and fixed investment. However, the IV estimates in columns 6 and 8 suggest a significantly negative

interation between credit rationing and credit needs for fixed investment, implying that credit rationed firms with needs for fixed investment are less likely to join a supply chain.

Further evidence is provided in columns 9-12. The survey asks firms the main reasons leading to collaboration with other firms ("What are the two main reasons that led the firm to participate in forms of aggregation and/or collaboration between companies?"). *Increase_ capital* is a dummy variable taking the value of one if a firm viewed "increasing the capital available to create growth projects" as the main reason. Similar to fixed investment, growth projects are long-term investments. As shown in columns 9-12, we find no significant relationship between the need for financing growth projects and the probability of joining a supply chain. In addition, this relationship does not differ between credit rationed and non-rationed firms. Again, the higher propensity to participate in a supply chain by credit rationed firms appears to be unrelated to the need for financing long-term growth projects.

In sum, the results in Table 4 suggest that the higher probability of participating in a supply chain by credit rationed firms is likely driven by the credit need for working capital rather than the need for financing long-term investments.

### 7.2 Position in supply chains

Kalemli-Ozcan, Kim, Shin and Sorensen (2013) argue that upstream firms' working capital is more sensitive to fluctuations in financial conditions than it is for downstream firms. In fact, upstream firms need to hold more equity in order to satisfy incentive compatibility constraints. In Table 7, we examine a firm's position in a supply chain. The dependent variable is a dummy that equals one if a firm is upstream in the supply chain, and zero if the firm is downstream in the supply chain or if the firm is not part of a supply chain. The OLS and probit estimates displayed in columns 1 and 3 suggest that credit rationed firms are more likely to be upstream in a supply chain. However, the 2SLS and bivariate probit results suggest no significant effect of credit rationing on the position in the supply chain. When we use the number of banks to capture financial constraints as shown in columns 5-6, we find that firms that borrow from more banks (that is, with a weaker relationship with the main bank) are less likely to be upstream in a supply chain. However, the 2SLS estimates suggest no significant relationship between the number of banks and the likelihood of participating in a supply chain. Finally, the 2SLS estimates in column 8 suggest that firms with a longer relationship with their main bank (i.e., less likely to be financially constrained) are less likely to be upstream in a supply chain. Thus, Table 7 provides a mixed picture of the relationship between financial constraints and the position in a supply chain.

### 7.3 Domestic and international supply chains

If a supply chain stretches from Italy to foreign countries, the lag between the cost of production and the receipt of payment from sales could be longer than if the supply chain is entirely domestic. As a result, firms in an global supply chain could have a higher demand for working capital to fill the gap between the point when a cost is incurred and when payments are received. According to this argument, one could expect credit constraints to have a larger impact on firms' decision to join an international supply chain. On the other hand, foreign partners might be reluctant to provide liquidity in the case of shortage of credit incurred by Italian firms since the assets held at Italian firms might be hard to be verified by their foreign partners. This would imply that credit rationed firms are less likely to join an international supply chain. In Table 8, we examine the impact of financial constraints on the decision to join a domestic supply chain or an international supply chain.

In Panel A, the OLS and probit estimates suggest a stronger effect of credit rationing on the participation in an international supply chain. However, the bivariate probit results suggest a weakly negative effect of credit rationing on the probability of joining an international supply chain. That is, credit rationed firms are less likely to be part of an international supply chain. In Panel B, we use the number of banks to capture credit constraints. Although the OLS estimates suggest no strong relationship between credit constraints and the probability of joining a supply chain (either domestic or international), the 2SLS estimates in column 6 show a significantly negative coefficient, suggesting that firms that borrow from more banks are less likely to participate in an international supply chain.

In Panel C, we use the length of the firm-bank relationships. The results are consistent with those tabulated in Panels A and B. The 2SLS estimates are significantly positive, implying that firms with a longer relationship with their main bank (i.e., less likely to be credit constrained) are more likely to join an international supply chain. Therefore, the results in Table 8 suggest that credit constraints might have a larger negative impact on the participation in an international supply chain than in a domestic supply chain.

### 7.4 Manufacturing sector

The earlier results are for the economy as a whole. In this section we focus on the manufacturing sector. Columns 1-4 of Table 9 show that credit rationed manufacturing firms are more likely to participate in a supply chain. The magnitude of the estimate is even larger than that for the economy as a whole. We then examine the decision to participate in a domestic or an international supply chain. Consistent with the results in Table 8, we find a stronger effect for the decision to join an international supply chain.

# 8 Conclusion

This paper has examined the impact of firms' access to financial (credit) markets on firms' decision to participate in supply chains. The results reveal that firms tend to rely on supply chains as a source of liquidity when they have difficult access to credit markets. We have also found that firms' especially perceive a benefit in joining supply chains as a source of working capital financing, while no such benefit appears to arise for long-term investments. Expectedly, the estimates also suggest that not all types of relationships within supply chains are alike in guaranteeing access to liquidity. For example, larger partners with long-term trade relationships appear to be especially valuable for firms exposed to financial constraints. Prior literature has consistently found that financial factors play an important role in firm's production and investments decision. Our results indicate that financial factors can also be crucial in shaping the organization itself of the production system, by influencing firms' incentive to participate in supply chains.

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**Figure 1**

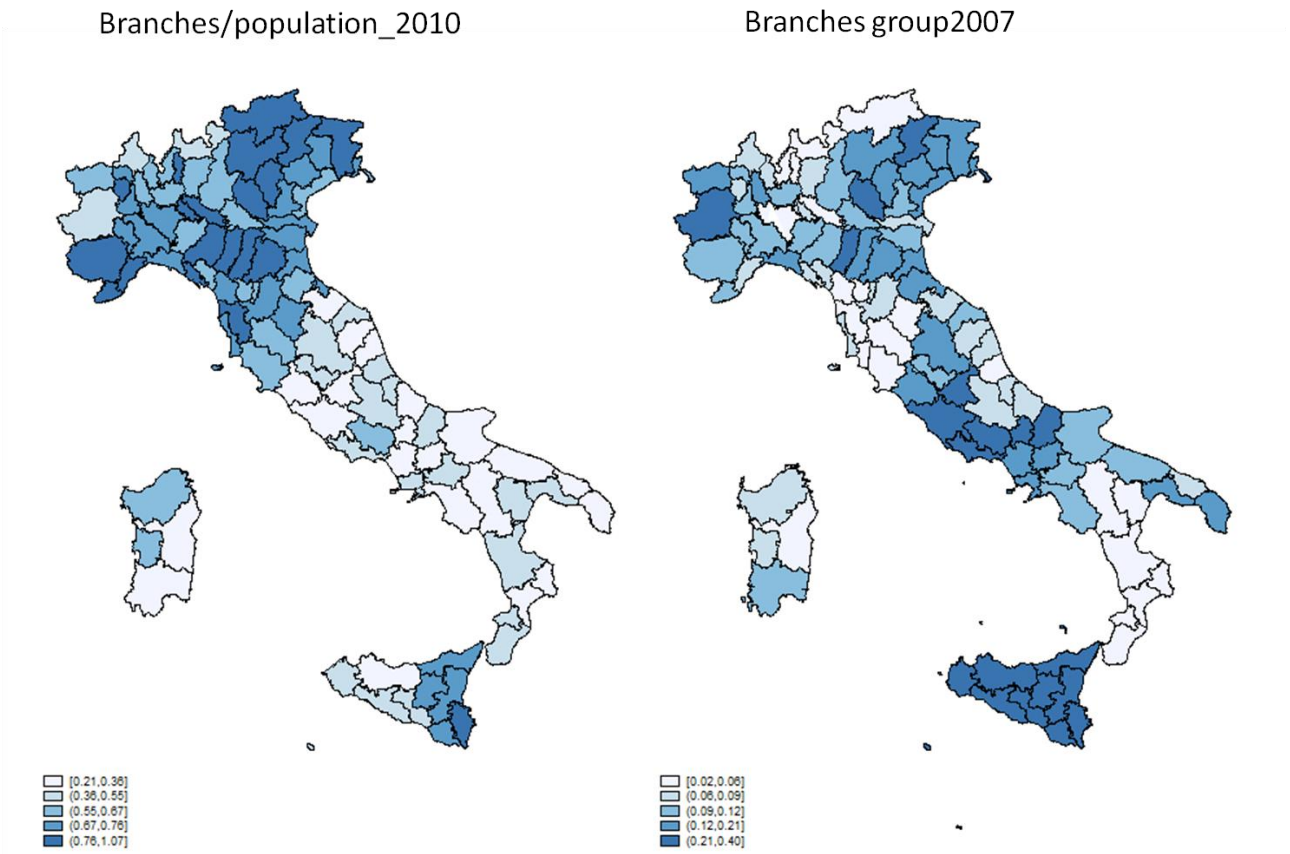
Branches/population_2010
[0.21,0.36]
(0.36,0.55]
(0.55,0.67]
(0.67,0.76]
(0.76,1.07]
Branches group2007
[0.02,0.06]
(0.06,0.09]
(0.09,0.12]
(0.12,0.21]
(0.21,0.40]

**Table 1. Summary statistics and description**

| Variable | Num. | Mean | Std. Dev. | Description |
|---|---|---|---|---|
| Supply chain | 4497 | 0.528 | *0.499* | Dummy that takes the value of one if the firm is in a supply chain |
| Sub contractor | 4497 | 0.108 | *0.310* | Dummy that takes the value of one if the firm is a sub-contractor |
| Sucontractor foreign | 4497 | 0.058 | *0.233* | Dummy that takes the value of one if the firm is a sub-contractor of foreign firm |
| Upstream Supply chain | 4497 | 0.162 | *0.369* | Role in the supply chain: the firm purchases row materials and produces an intermediate good |
| Medium Supply chain | 4497 | 0.102 | *0.303* | Role in the supply chain: the firm uses and produces semi-finished intermediate goods |
| End Supply chain | 4497 | 0.264 | *0.441* | Role in the supply chain: the firm uses semi-finished intermediate goods and produces final goods |
| North East | 7433 | 0.312 | *0.463* | Dummy that takes the value of one if the firm is located in the North East of Italy |
| North West | 7433 | 0.264 | *0.441* | Dummy that takes the value of one if the firm is located in the North West of Italy |
| Center | 7433 | 0.186 | *0.389* | Dummy that takes the value of one if the firm is located in the Center of Italy |
| South | 7433 | 0.237 | *0.237* | Dummy that takes the value of one if the firm is located in the South of Italy |
| Age | 7121 | 18.959 | *17.818* | Number of years since inception |
| Number of Employees | 7153 | 15.380 | *42.401* | Total number of employees in the year of the survey |
| Percentage graduate | 7279 | 2.302 | *8.245* | Percentage of employees with university degree |
| Corporation | 7433 | 0.259 | *0.438* | Duumy on whether the firm is a private limited company (LTD) or a public limited company (PLCs) |
| Family ownership | 7368 | 0.903 | *0.296* | Family is a dummy that takes the value of one if the main shareholder is a family or an individual |
| INNO Product | 7436 | 0.519 | *0.500* | Dummy that takes the value of one if the firm makes product innovation, zero otherwise |
| INNO Process | 7433 | 0.584 | *0.493* | Dummy that takes the value of one if the firm makes drastic process innovation, zero otherwise |
| EXPORT | 7433 | 0.190 | *0.392* | Dummy that takes the value of one if the firm exports, zero otherwise |
| FDI | 7436 | 0.042 | *0.201* | Dummy that takes the value of one if the firm makes FDI, zero otherwise |
| Num Foreign Mkt | 1411 | 3.667 | *2.625* | Number of foreign markets |
| Multiple Market | 1394 | 0.775 | *0.418* | Dummy that takes the value of one if the firm exports in more than one area, zero otherwise |
| Credit Rationing Weak | 7247 | 0.377 | *0.485* | Dummy that takes the value of one if the firm is credit rationed, zero otherwise |
| Number Banks | 7433 | 2.422 | *2.094* | Number of banks |
| Main Bank_Internation | 7436 | 0.801 | *0.400* | Dummy that takes the value of one if the main bank of the firm is internationalized, zero otherwise |
| Relationship lenght | 7433 | 13.529 | *11.202* | The length of the relationship with the main bank |
| Relationship extent | 5723 | 0.389 | *0.325* | Share of the debt with the main bank on total bank debt |
| Bank debt/totass | 5490 | 0.273 | *0.261* | Share of bank debt on total assets |
| Agriculture | 7436 | 0.019 | *0.135* | Sector of activity |
| Construption | 7436 | 0.100 | *0.300* | Sector of activity |
| Commerce | 7436 | 0.284 | *0.451* | Sector of activity |
| Tourism | 7436 | 0.027 | *0.161* | Sector of activity |
| Services | 7436 | 0.301 | *0.459* | Sector of activity |
| Industry | 7436 | 0.262 | *0.440* | Sector of activity |

**Table 2. Supply chain**

| | OLS | 2SLS | probit | Bi-probit | OLS | 2SLS | OLS | 2SLS |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Rationing | 0.046*** | 1.007* | 0.047*** | 0.187** | | | | |
| | (0.017) | (0.553) | (0.017) | (0.079) | | | | |
| Number of banks | | | | | -0.004 | 0.167* | | |
| | | | | | (0.005) | (0.092) | | |
| Relationship length | | | | | | | -0.001 | -0.267** |
| | | | | | | | (0.008) | (0.115) |
| AGE | -0.001** | 0.000 | -0.001** | -0.001* | -0.001** | -0.002** | -0.001** | 0.005* |
| | (0.000) | (0.001) | (0.000) | (0.000) | (0.000) | (0.001) | (0.000) | (0.003) |
| ln_EMPL | -0.017** | -0.033** | -0.017** | -0.001 | -0.013 | -0.134** | -0.016* | -0.004 |
| | (0.009) | (0.014) | (0.009) | (0.004) | (0.009) | (0.066) | (0.009) | (0.011) |
| Corporation | -0.019 | 0.027 | -0.019 | -0.019 | -0.023 | -0.109** | -0.021 | 0.007 |
| | (0.027) | (0.045) | (0.027) | (0.014) | (0.026) | (0.052) | (0.027) | (0.031) |
| Partnership | -0.060** | -0.054 | -0.061*** | -0.019* | -0.061*** | -0.054** | -0.064*** | -0.008 |
| | (0.023) | (0.033) | (0.023) | (0.012) | (0.023) | (0.024) | (0.024) | (0.037) |
| spo_pop_2009 | -0.065 | 0.029 | -0.067 | -0.039 | -0.068 | -0.308** | -0.062 | 0.024 |
| | (0.070) | (0.112) | (0.112) | (0.040) | (0.067) | (0.132) | (0.066) | (0.098) |
| Center | -0.064** | -0.096*** | -0.065** | -0.019* | -0.060** | -0.081** | -0.060** | -0.066** |
| | (0.029) | (0.032) | (0.029) | (0.010) | (0.029) | (0.038) | (0.028) | (0.027) |
| South | -0.065* | -0.154** | -0.066* | -0.005 | -0.057* | -0.104** | -0.051 | -0.049 |
| | (0.034) | (0.062) | (0.034) | (0.015) | (0.033) | (0.043) | (0.033) | (0.039) |
| ***Instruments*** | | | | | | | | |
| share_gruppo | | -0.134* | | -0.504** | | -1.402*** | | 0.917*** |
| | | (0.077) | | (0.199) | | (0.357) | | (0.187) |
| diff_UC_Cap | | -0.164*** | | -0.474*** | | -0.692** | | 0.512*** |
| | | (0.056) | | (0.150) | | (0.322) | | (0.146) |
| Ind & Area dummies | Y | Y | Y | Y | Y | Y | Y | Y |
| Observations | 4,176 | 4,176 | 4,176 | 4,176 | 4,239 | 4,239 | 4,163 | 4,163 |
| R-squared | 0.016 | | 0.012 | | 0.014 | | 0.015 | |

*Note* : ***, **, * show significance at the 1%, 5%, and 10% level, respectively.

**Table 3. Supply chain: robustnes checks**

| | Additional control | | | | Additional instrument | | | | Placebo tests | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2SLS | biprobit | 2SLS | 2SLS | 2SLS | biprobit | 2SLS | 2SLS | 2SLS | 2SLS | 2SLS | 2SLS | 2SLS | 2SLS |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) |
| Rationing | 1.045** | 0.182** | | | 0.872* | 0.183** | | | 0.726 | | | -0.189 | | |
| | (0.515) | (0.074) | | | (0.491) | (0.075) | | | (1.426) | | | (0.989) | | |
| Number of banks | | | 0.170** | | | | 0.166* | | | -0.250 | | | -0.178 | |
| | | | (0.086) | | | | (0.091) | | | (0.632) | | | (0.520) | |
| Relationship length | | | | -0.273*** | | | | -0.271** | | | -0.288 | | | -0.181 |
| | | | | (0.106) | | | | (0.117) | | | (0.459) | | | (0.466) |
| ***Instruments*** | | | | | | | | | | | | | | |
| Share UniCredit group | -0.133* | -0.494** | -1.410*** | 0.920*** | -0.109 | -0.441** | -1.411*** | 0.888*** | | | | | | |
| | (0.077) | (0.199) | (0.354) | (0.187) | (0.077) | (0.206) | (0.368) | (0.180) | | | | | | |
| UniCredit - Capitalia | -0.170*** | -0.501*** | -0.666** | 0.499*** | -0.167*** | -0.481*** | -0.691** | 0.515*** | | | | | | |
| | (0.059) | (0.153) | (0.314) | (0.153) | (0.058) | (0.160) | (0.324) | (0.147) | | | | | | |
| Δ Share first five banks | | | | | -0.232 | -0.594* | 0.086 | 0.258 | | | | | | |
| | | | | | (0.155) | (0.351) | (0.589) | (0.336) | | | | | | |
| Share Intesa SanPaolo | | | | | | | | | 0.102 | -0.328 | -0.334 | | | |
| | | | | | | | | | (0.103) | (0.467) | (0.316) | | | |
| Share MPS | | | | | | | | | | | | -0.243 | -0.606 | -0.492 |
| | | | | | | | | | | | | -0.251 | (1.032) | (0.450) |
| Ind & Area dummies | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Additional control | Y | Y | Y | Y | N | N | N | N | N | N | N | N | N | N |
| Observations | 4,176 | 4,176 | 4,239 | 4,163 | 4,176 | 4,176 | 4,163 | 4,163 | 4,176 | 4,239 | 4,163 | 4,174 | 4,237 | 4,161 |

*Note* : ***, **, * show significance at the 1%, 5%, and 10% level, respectively.

**Table 4. Supply chain: working capital, fixed investment, and growth projects**

| | Working capital | | | | fixed investment | | | | growth projects | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | OLS | 2SLS | probit | mvprobit | OLS | 2SLS | probit | mvprobit | OLS | 2SLS | probit | mvprobit |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
| Rationing | 0.032 | -1.588 | 0.033 | -0.331*** | 0.014 | 0.524 | 0.014 | 0.259*** | 0.036 | 1.718 | 0.037 | 0.094 |
| | (0.029) | (3.168) | (0.029) | (0.081) | (0.026) | (0.508) | (0.027) | (0.012) | (0.025) | (5.142) | (0.025) | (0.064) |
| Credit for work capit | -0.021 | -4.301 | -0.021 | -0.584*** | | | | | | | | |
| | (0.050) | (7.726) | (0.050) | (0.013) | | | | | | | | |
| RATION*work capit | 0.012 | 8.176 | 0.012 | 0.700*** | | | | | | | | |
| | (0.064) | (14.747) | (0.064) | (0.022) | | | | | | | | |
| Credit for fix inv | | | | | -0.070* | 0.923* | -0.070* | 0.196*** | | | | |
| | | | | | (0.039) | (0.535) | (0.039) | (0.043) | | | | |
| RATIO*fix inv | | | | | 0.111 | -1.882* | 0.109* | -0.365*** | | | | |
| | | | | | (0.069) | (1.056) | (0.065) | (0.013) | | | | |
| Incr_Capital | | | | | | | | | -0.028 | 1.309 | -0.028 | -0.071 |
| | | | | | | | | | (0.032) | (5.997) | (0.032) | (0.082) |
| Ration_Incr_Capital | | | | | | | | | -0.043 | -3.013 | -0.044 | -0.111 |
| | | | | | | | | | (0.055) | (13.37) | (0.055) | (0.139) |
| ***Instruments*** | | | | | | | | | | | | |
| share_gruppo | | -0.047 | | 0.387 | | -0.051 | | -0.645** | | -0.164 | | 2.781 |
| | | (0.122) | | (0.312) | | (0.121) | | (0.300) | | (0.109) | | (13.835) |
| diff_UC_Cap | | -0.302** | | -0.234 | | -0.298*** | | -0.609*** | | - | | -4.898 |
| | | (0.102) | | (0.435) | | (0.102) | | (0.198) | | (0.095) | | (12.548) |
| Ind & Area dummies | Y | Y | Y | Y | Y | Y | | Y | Y | Y | | Y |
| Observations | 1,715 | 1,715 | 1,715 | 1,715 | 1,715 | 1,715 | 1,715 | 1,715 | 2,302 | 2,302 | 2,302 | 2,302 |
| R-squared | 0.023 | | 0.017 | | 0.025 | | 0.018 | | 0.016 | | 0.011 | |

*Note* : ***, **, * show significance at the 1%, 5%, and 10% level, respectively.

**Table 5. Characteristics of partners in supply chain: Size of subcontractor and duration of relationship with partner**

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| | large partner (input supplier) | | | | large partner (input acquirer) | | | |
| | OLS | 2SLS | probit | bi-probit | OLS | 2SLS | probit | bi-probit |
| Rationing | 0.013** | 0.003 | 0.012** | 0.001** | 0.007*** | -0.100 | 0.006*** | -0.001 |
| | (0.006) | (0.133) | (0.005) | (0.000) | (0.002) | (0.072) | (0.002) | (0.001) |
| ***Instruments*** | | | | | | | | |
| share_gruppo | | -0.134* | | -0.371* | | -0.134* | | -0.390* |
| | | (0.077) | | (0.212) | | (0.077) | | (0.207) |
| diff_UC_Cap | | -0.164*** | | -0.448*** | | -0.164*** | | -0.455*** |
| | | (0.056) | | (0.172) | | (0.056) | | (0.149) |
| Observations | 4,176 | 4,176 | 4,176 | 4,176 | 4,176 | 4,176 | 4,176 | 4,176 |
| R-squared | 0.027 | | 0.026 | | 0.006 | | -0.373 | |
| | long relationship (input supplier) | | | | long relationship (input aquirer) | | | |
| | OLS | 2SLS | probit | bi-probit | OLS | 2SLS | probit | bi-probit |
| Rationing | 0.027*** | -0.324 | 0.024*** | -0.008 | 0.022*** | 0.061 | 0.023*** | 0.001* |
| | (0.008) | (0.252) | (0.007) | (1.207) | (0.005) | (0.159) | (0.005) | (0.000) |
| ***Instruments*** | | | | | | | | |
| share_gruppo | | -0.134* | | -0.396** | | -0.134* | | -0.329* |
| | | (0.077) | | (0.193) | | (0.077) | | (0.192) |
| diff_UC_Cap | | -0.164*** | | -0.489*** | | -0.164*** | | -0.483*** |
| | | (0.056) | | (0.127) | | (0.056) | | (0.163) |
| Observations | 4,176 | 4,176 | 4,176 | 4,176 | 4,176 | 4,176 | 4,176 | 4,176 |
| R-squared | 0.037 | | 0.04 | | 0.021 | | 0.019 | |

*Note* : ***, **, * show significance at the 1%, 5%, and 10% level, respectively.

**Table 6. Characteristics of the main bank in supply chain: Bank not consider**

| | OLS | 2SLS | probit | bi-probit | OLS | 2SLS | OLS | 2SLS |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Rationing | 0.032*** | 0.443 | 0.032*** | 0.076*** | | | | |
| | (0.012) | (0.321) | (0.012) | (0.022) | | | | |
| Number of banks | | | | | -0.003 | 0.070 | | |
| | | | | | (0.004) | (0.051) | | |
| Rel. length (ln) | | | | | | | 0.006 | -0.123* |
| | | | | | | | (0.008) | (0.070) |
| ***Instruments*** | | | | | | | | |
| share_gruppo | | -0.134 | | -0.022 | | -1.402*** | | 0.916*** |
| | | (0.077) | | (0.014) | | (0.357) | | (0.187) |
| diff_UC_Cap | | -0.164*** | | -0.026*** | | -0.692** | | 0.511*** |
| | | (0.056) | | (0.012) | | (0.321) | | (0.146) |
| Ind & Area dummies | Y | Y | Y | Y | Y | Y | Y | Y |
| Observations | 4,176 | 4,176 | 4,176 | 4,176 | 4,239 | 4,239 | 4,163 | 4,163 |
| R-squared | 0.006 | | | | 0.004 | | 0.005 | |

*Note* : ***, **, * show significance at the 1%, 5%, and 10% level, respectively.

**Table 7. Upstream position in the supply chain**

| | OLS | 2SLS | probit | bi-probit | OLS | 2SLS | OLS | 2SLS |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Rationing | 0.023** | 0.379 | 0.024** | 0.046 | | | | |
| | (0.012) | (0.374) | (0.012) | (0.028) | | | | |
| Num of banks | | | | | -0.009*** | 0.112 | | |
| | | | | | (0.003) | (0.072) | | |
| Rel. length (ln) | | | | | | | 0.01 | -0.163* |
| | | | | | | | (0.006) | (0.093) |
| ***Instruments*** | | | | | | | | |
| share_gruppo | | -0.135* | | -0.464* | | -1.402*** | | 0.916*** |
| | | (0.077) | | (0.263) | | (0.357) | | (0.187) |
| diff_UC_Cap | | -0.165*** | | -0.407** | | -0.692** | | 0.512*** |
| | | (0.056) | | (0.162) | | (0.322) | | (0.146) |
| Ind & Area dummies | Y | Y | Y | Y | Y | Y | Y | Y |
| Observations | 4,176 | 4,176 | 4,176 | 4,176 | 4,239 | 4,239 | 4,163 | 4,163 |
| R-squared | 0.012 | | 0.013 | | 0.011 | | 0.01 | |

*Note* : ***, **, * show significance at the 1%, 5%, and 10% level, respectively.

**Table 8. Subcontracting**

| | Domestic | | | | International | | | |
|---|---|---|---|---|---|---|---|---|
| | OLS | 2SLS | probit | bi-probit | OLS | 2SLS | probit | bi-probit |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Rationing | 0.012*** | -0.012 | 0.012*** | -0.003 | 0.032*** | -0.274 | 0.030*** | -0.012 |
| | (0.004) | (0.089) | (0.004) | (0.017) | (0.007) | (0.223) | (0.006) | (0.028) |
| ***Instruments*** | | | | | | | | |
| share_gruppo | | -0.164** | | -0.450** | | -0.141* | | -0.463** |
| | | (0.073) | | (0.190) | | (0.076) | | (0.192) |
| diff_UC_Cap | | -0.137** | | -0.356** | | -0.165*** | | -0.441*** |
| | | (0.059) | | (0.155) | | (0.057) | | (0.142) |
| Observations | 3,931 | 3,931 | 3,931 | 3,931 | 4,119 | 4,119 | 4,119 | 4,119 |
| R-squared | 0.012 | | | | 0.039 | | | |
| Num of banks | 0.000 | -0.002 | | | 0.002 | -0.058** | | |
| | (0.001) | (0.012) | | | (0.002) | (0.025) | | |
| ***Instruments*** | | | | | | | | |
| share_gruppo | | -1.453*** | | | | -1.422*** | | |
| | | (0.342) | | | | (0.354) | | |
| diff_UC_Cap | | -0.756** | | | | -0.674** | | |
| | | (0.335) | | | | (0.321) | | |
| Observations | 3,988 | 3,988 | | | 4,182 | 4,182 | | |
| R-squared | 0.009 | | | | 0.036 | | | |
| Rel. length (ln) | -0.001 | 0.003 | | | 0.002 | 0.092** | | |
| | (0.002) | (0.018) | | | (0.004) | (0.041) | | |
| ***Instruments*** | | | | | | | | |
| share_gruppo | | 0.915*** | | | | 0.896*** | | |
| | | (0.080) | | | | (0.142) | | |
| diff_UC_Cap | | 0.561*** | | | | 0.527*** | | |
| | | (0.141) | | | | (0.151) | | |
| Observations | 3,915 | 3,915 | | | 4,106 | 4,106 | | |
| R-squared | 0.009 | | | | 0.036 | | | |

*Note* : ***, **, * show significance at the 1%, 5%, and 10% level, respectively.

**Table 9. Robustness: Manufacturing only**

| | Supply chain | | | | Domestic subcontractor | | | | International subcontractor | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | OLS | 2SLS | probit | bi-probit | OLS | 2SLS | probit | bi-probit | OLS | 2SLS | probit | bi-probit |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
| RATIONING | 0.067** | 1.143 | 0.068** | 0.158*** | 0.016* | 0.138 | 0.015** | -0.000 | 0.046*** | -0.746 | 0.047*** | -0.245 |
| | (0.029) | (4.357) | (0.029) | (0.010) | (0.009) | (0.493) | (0.009) | (0.009) | (0.013) | (1.536) | (0.013) | (0.442) |
| ***Instruments*** | | | | | | | | | | | | |
| share_gruppo | | -0.063 | | -0.472 | | -0.034 | | -0.128 | | -0.116 | | -0.012 |
| | | (0.185) | | (0.412) | | (0.180) | | (0.564) | | (0.180) | | (0.324) |
| diff_UC_Cap | | 0.031 | | -0.235 | | 0.081 | | 0.218 | | 0.019 | | 0.000 |
| | | (0.139) | | (0.373) | | (0.136) | | (0.406) | | (0.136) | | (0.014) |
| Ind & Area dummies | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Observations | 1,504 | 1,504 | 1,504 | 1,504 | 1,354 | 1,354 | 1,354 | 1,354 | 1,482 | 1,482 | 1,482 | 1,482 |
| R-squared | 0.012 | | | | 0.012 | | | | 0.013 | | | |

*Note* : ***, **, * show significance at the 1%, 5%, and 10% level, respectively.