# Global Value Chains, Innovation and Performance: Firm-Level Evidence from Italy

Emanuele Brancati[a,b], Raffaele Brancati[b],
and Andrea Maresca[b]

April 29, 2015

ABSTRACT

This paper contributes to recent studies on international production and Global Value Chains (GVCs) by testing the effect of GVC participation on firms' innovative activity and performance. In addressing this research question, we focus on the Italian experience and propose a novel approach to identify and classify GVCs. Our findings support the existence of a premium for globally-connected firms –over and above export-driven effects–, but mainly confined to highly-capable "relational" suppliers. Even after controlling for a rich set of firm-specific observable and unobservable factors, we find significant effects on firms' performance and productivity, as well as on the extensive and intensive margins of innovation, R&D, and export. We interpret this result as an evidence of the combined role played by chain connections and firms' capacity in the generation, transfer, and diffusion of knowledge.

**JEL classification:** D24, F23, F26, O30.

**Keywords:** Global value chains, innovation, R&D, export, productivity.

[a] LUISS Guido Carli University, viale Romania 32, 00197 Rome (Italy).

[b] MET, via Sabotino 2A, 00195 Rome (Italy).

We wish to thank Davide Castellani, Arianna Galliera, Lilian Giardino-Karlinger, Paolo Giordani, Anna Giunta, Saul Lach, Carlo Peitrobelli, Manuel Romagnoli, Timothy Sturgeon, Antonello Zanfei, seminar participants at University of Venice Ca' Foscari, c.MET05, and Explaining Economic Change Workshop for their insightful comments. Corresponding author: Emanuele Brancati, Tel +39-06-3722636; email: ebrancati@luiss.it, e.brancati@met-economia.it.

# 1 Introduction

The fragmentation of the production processes, the changes in distribution channels and transportation costs, and the diffusion of information technologies that characterized the last decades turned the worldwide productive system upside down. Globalization brought profound metamorphoses in the international division of labor, with widespread phenomena of outsourcing and off-shoring that further reduced firms' degree of vertical integration (Hummels et al, 2001; OECD, 2013; Baldwin and Venables, 2013). Within this evolving framework, companies were called for a radical reorganization of their activities that frequently translated into the creation or reinforcement of cross-border inter-firm connections; especially in the recent crises when the involvement in global value chains (GVCs) provided firms (even the small ones) with an invaluable chance to participate in global networks, survive, and grow despite the stagnation of domestic markets.

This paper contributes to the literature on international production and value chains' by testing the effect of GVC participation on firm innovativeness and performance. We go beyond standard approaches analyzing the link between internationalization and corporate productivity, and ask whether firms' own way to contribute to the global production affects their knowledge exchange and learning opportunities; this, in turn, may heavily influence the "upgrading capacity" of a company, defined as its propensity to innovate and grow. We address this research question by proposing a novel approach to identify GVCs and their modes of participation, and exploring heterogeneities along firms' performance, productivity, innovativeness, R&D, and export activity between 2008 and 2013. Importantly, we document effects that are over and above the positive spillovers linked to the penetration into international markets.

The empirical framework of the paper is the Italian economy, which represents an interesting laboratory to provide new insights on this field of research. First of all, it gives the chance to analyze the effect of GVCs within developed countries. This issue is crucial in our understanding of how the global economy works, especially since most of the existing literature focused on LDCs offering an unfavorable framework for firms' upgrading conditions (Humphrey and Schmitz, 2002; Giuliani et al, 2005).

At the same time, the Italian system provides a suitable environment for a broad diffusion of value chains: an industry characterized by a large number of small suppliers, with high division of labor, and frequent inter-firm connections. While traditional studies on Italy emphasize the role of industrial clusters,

districts, and of buyer-supplier spatial proximity, we regard recent economic mutations as a chance to make a change in perspective. The globalization, the business opportunities provided by new technologies, and the competitive pressure from emerging countries triggered an evolutionary process that pushed firms to pursue a global dimension by stretching the borders of their networks (Amighini and Rabellotti, 2006; Chiarvesio and Di Maria, 2009; Chiarvesio et al, 2010). These arguments are even more relevant in recent times, when the Lehman and sovereign debt crises brought deep contractions in the domestic demand, and the opportunity of global-scale linkages represented a crucial factor for firms' survival. In other words, the recent Italian experience offers a privileged point of view to explore the role of GVCs in affecting firms' strategies and performance.

There are several features of the analysis that are worth emphasizing. First, we take advantage of a newly available database –the MET survey on Italian companies– based on a sample of firms that is truly representative of the entire industrial system. The dataset comes from the widest survey administrated in a single European country and allows to study even the behavior of micro-sized companies with less than ten employees. The latter are typically excluded from previous works despite their huge incidence (more than 90% of firms in Italy, but significant in other countries too) and the great potential benefits they can obtain from international linkages. The richness of the dataset is exploited to propose a novel empirical definition of value chains and of the modes of participation in GVCs (i.e., their "forms of governance") based upon type and destination markets of goods, type and origin markets of inputs purchased, existence and length of inter-firm relationships, and firms' degree of involvement in the conception of the final product. Our empirical approach improves upon the use of simplistic proxies and permits to analyze the role of GVCs over and above the mere effects of internationalization. The database also provides information on firm structural characteristics, choices, and strategies allowing to explore several dimensions of "upgrading". Even if our conception of upgrading is more oriented toward strategic behaviors (from a detailed breakdown by types of innovation, to firm investment in R&D projects and export activity), we also provide results for the magnitude of the upgrade undertaken (intensive margins) and for firms' productivity and performance.

Importantly, we take advantage of the panel dimension of our dataset to control for the possible self selection of more dynamic companies into GVCs. The main empirical strategy employs random-effects

models with Mundlak's correction (inclusion of regressors' time averages), but we also implement fixed-effects estimators (linear probability and conditional logistic models), two-step system-GMM, and matching techniques to further take care of relevant econometric issues.

The core findings of the paper are easily summarized. Although firms involved in GVCs display an upgrading propensity that is significantly higher than "stand-alone" companies or enterprises in national value chains, the mere affiliation to GVCs is not sufficient for firm success. The type of GVC governance (i.e., the system of relationships within a value chain) dramatically affects firms' innovativeness and performance. A predominant role is played by the capability of suppliers; a factor that allows not only to handle the existent stock of knowledge, but also to access and exploit new inflows from external sources. Highly-capable firms involved in "relational GVCs", have a 4%-to-7% higher probability of innovating (especially for the introduction of new products) and undertaking R&D projects. *Vice versa*, other forms of GVCs participations –namely arm-length, quasi-hierarchical, and hierarchical– seem to have no significant role in fostering firm likelihood of upgrading. Interestingly, GVC connections also boost the exporting probability of previously non-internationalized companies, with an impact that is quite homogeneous across the different types of governance.

These effects are not limited to firms' probability of implementing upgrading strategies, but also extend to the magnitude of the activity undertaken (intensive margins) and to firm performance. Our findings are stable across a number of robustness tests controlling for possible endogeneity, simultaneity bias, self selection, persistence of the phenomena of interest, and even for firm observable and unobservable heterogeneity.

The remainder of the paper is as follows. Section 2 presents the related literature and further discusses the main contributions of this work. Section 3 outlines the empirical strategy and our definitions of value chain and GVC governance. Section 4 provides details on the dataset employed and descriptive statistics. Section 5 shows the results and section 6 concludes.

## 2 Related literature

This paper relates and contributes to two main streams of research: the ones on international trade and performance, and on the relationship between GVCs and upgrading strategies.

The first, and most known, strand of the literature explores the link between internationalization and firm performance, often analyzing the mechanism through which import and export flows affect productivity and output growth. The aim is typically to disentangle two alternative, but not mutually exclusive, hypotheses: learning-by-exporting effects –in which knowledge flows from international markets foster the post-entry performance of export starters– and self selection –whereby productivity differentials are attributable to the *ex ante* selection of more productive firms into international environments. A massive amount of papers explores these channels on micro (often longitudinal) data from virtually any kind of economy: highly industrialized countries (Bernard and Jensen, 1999; Bernard and Wagner, 2001; Delgado et al, 2002; Head and Ries, 2003; Girma et al, 2004; Castellani and Zanfei, 2007), Latin America (Clerides et al, 1998; Pavcnik, 2002), Asian countries (Aw et al, 2001; Hallward-Driemeier et al, 2002; Kraay, 2006), and least developed economies (Van Biesebroeck, 2005).[1] Their results are often mixed, leaving room for additional explorations on the direction of causality between export and productivity gains.[2]

With their specific focus on firms' degree of internationalization, most works appear to disregard an important part of the story: firms' own way to participate in global markets can dramatically affect knowledge exchanges and learning opportunities. Indeed, "it is not only a matter of whether to participate into the global economy, but how to do so in a way which provides sustainable growth" (Kaplinsky, 2004). In this regard, the GVC approach provides a perspective that is quite complementary to the view of knowledge transfer emerged from the international production literature, with an emphasis on the role of coordination and governance in the global production and international trade.

Drawing from the transaction cost literature, Gereffi and Korzeniewicz (1994) and Gereffi (1999) developed a framework linking the concept of value-added chains to the global organization of industries. Since their seminal papers, a growing amount of works reinterpreted the international productive system and the functioning of inter-firm linkages in the light of the GVC scheme (Gereffi and Kaplinsky, 2001; Henderson et al, 2002; Humphrey and Schmitz, 2002; Sturgeon et al, 2008; Navas-Alemán, 2011; Antràs and Chor, 2013; among others). The emphasis of these studies is that complex and organized relationships produce positive

[1] For a more comprehensive review see Wagner (2007).

[2] At the theoretical level, a number of papers (including Melitz, 2003; Bernard et al, 2003; Melitz et al, 2004; Yeaple, 2005; Ghironi and Melitz, 2005) take the results from the empirical literature to develop models of international trade with heterogeneous firms aimed at studying the linkage between productivity and export.

effects that go beyond the mere sum of bilateral connections because of the flow of managerial expertise and technical knowledge from global leaders along the chains. GVCs are thus seen as a fertile environment for the introduction of product and process innovation, as well as for functional and inter-chain upgradings (Dolan and Humphrey, 2000; Humphrey and Schmitz, 2002). However, the mere participation in GVCs should not be considered as synonymous for firm upgrading propensity; the nature of the relationships among the actors involved in the chain have crucial implications for development because of its influence on the generation, transfer, and diffusion of knowledge (Altenburg, 2006; Pietrobelli and Rabellotti, 2011).

In this regard, the work of Gereffi et al (2005) identifies three key determinants of value chain governance patterns:[3] (i) the complexity of information and knowledge transfer required for the transaction; (ii) the possibility to codify information and have efficient knowledge transmission; and (iii) the competence and capability of suppliers along the chain. The heterogeneous set of buyer-supplier relationships is then simplified into five main forms of GVC governance –*markets*, *modular*, *hierarchical*, *captive*, and *relational*– each one characterized by different channels of knowledge transfer: from spillovers and imitation (marked-based relationships) to standards, codes, and technical definitions (modular), from the turnover of skilled workers (hierarchical) to direct knowledge transfers (captive) or mutual learning (relational GVCs).[4]

While all value chain relationships imply some degree of information transmission, the extent to which knowledge is created, transferred, and adopted varies considerably across forms of governance.[5] In particular, relational GVCs are considered to offer the ideal conditions for upgrading (Humphrey and Schmitz, 2002) because of the mutual learning from face-to-face interactions, and, especially, the high level of skills of the

[3] The notion of *governance* of the value chains relates to the "authority and power relationships that determine how financial, material, and human resources are allocated and flow within a chain" (Gereffi, 1994).

[4] *Markets* are based upon simple market relationships with low degree of dependence of the supplier. The transactions are easily codified and performed with little explicit coordination. In *modular* GVCs transactions are based on complex goods that are produced following customers' specifications. The product technological content is easy to codify so that complex information can be exchanged with little explicit coordination. Codifiability allows for the use of generic machineries (i.e., low asset specificity) implying low degree of dependence for suppliers. *Hierarchical* relationships are based upon in-house production, which are characterized by a high degree of vertical integration and a managerial control going from headquarters to subsidiaries and affiliates. In *captive* GVCs transactions involve suppliers that are heavily dependent on final firms because of significant switching costs. Captive GVCs imply a high degree of monitoring and control by the lead firm committing complex products to lowly-capable suppliers. Finally, *relational* GVCs are characterized by complex interactions between buyers and sellers with strong mutual dependence. Product specifications cannot be codified, transactions are complex, and characterized by a high level of asset specificity as well as great suppliers' capability.

[5] A collateral strand of the GVC literature specifically explores firm upgrading. Humphrey and Schmitz (2002) focus on LDCs to show the relevance of commercial transactions, investments, and knowledge flows in fostering upgrading processes. The latter are closely related to a firm learning mechanism that crucially depends on the specific form of governance within the GVC (Morrison et al, 2008; Sturgeon and Memedovic, 2010; Pietrobelli and Rabellotti, 2011). Similarly, Bazan and Navas-Alemán (2004) explore the effect of power asymmetry between committing firms and sellers, while Giuliani et al (2005) employ data on clusters from Latin America to show the positive role played by the complexity of the inter-firm relationships. Finally, Schmitz (2004) and Gereffi et al (2005) focus on the effect of technological change (and the evolution of specific production functions) on GVC governance.

firms involved (see section 3.2 for a detailed discussion).

Altogether, the GVC literature provides a different perspective to analyze the effects of internationalization on firm productivity and upgrading capacity: the critical issue is not only being internationalized, but the way firms participate in the global production process. Differences in the forms of governance underlying buyer-supplier relationships –for instance linked to dissimilar power asymmetries and firm capability– can strongly affect the knowledge transmission along the chains and are potentially able to explain heterogeneities in firms' upgrading propensity.

Despite the large number of works examining GVCs on a theoretical basis, the empirical evidence at the micro level is still underwhelming. The vast majority of papers focus on case studies or limit the analysis to specific industries –from footwear and apparel (Gereffi, 1999; Schmitz, 1999; Bair and Gereffi, 2001, 2003; Evgeniev and Gereffi, 2008; Gereffi and Frederick, 2010), to agriculture (Dolan and Humphrey, 2000; Fernandez-Stark et al, 2011), from electronics (Sturgeon, 2002; Borrus et al, 2003; Vind and Fold, 2007; Sturgeon and Kawakami, 2010), to chemicals (Kannegiesser, 2008), and motor vehicles (Humphrey, 2003; Sturgeon and Florida, 2004; Sturgeon et al, 2009; Sturgeon and Van Biesebroeck, 2010)–, while only a few examples exploit plant-level data.

Among the latter, Pietrobelli and Saliola (2008) focus on Thailand to document the positive role of buyer involvement with local suppliers in affecting productivity, technology diffusion, and output growth. Similarly, Saliola and Zanfei (2009) find that knowledge intensive relationships are positively associated with the presence of global buyers in the local market. Finally, Baldwin and Yan (2014) examine whether the integration of Canadian manufacturing companies into GVCs fosters firm productivity.

The literature on the Italian system is rich, but mainly related to outsourcing, off-shoring, and internationalization of supplier firms. Accetturo et al (2011) investigate the relationship between functional upgrading and firm performance between 2008 and 2009. Chiarvesio et al (2010) analyze the links among internationalization, innovation strategies, and performance of SMEs. Giovannetti et al (2015) document a positive association between the probability of internationalization and firms' involvement in *filiére* (on the 2011-wave of the MET survey). Finally, Giunta et al (2012) focus on sales growth, while Agostino et al (2014) analyze how suppliers' productivity is affected by firm capability.

This paper contributes to the existing GVC literature along several dimensions. First of all, we improve upon studies at the cluster/sector level by taking advantage of micro data on the entire economy. Although analyses on a few case studies allow for a detailed traceability of the relationships along a value chain, their results lack general validity (i.e., refer to very specific relationships) and cannot be adequately tested because of the limited sample size. Our paper provides insights on the role of GVCs for the overall economy by exploiting up-to-date data on a large number of companies belonging to both manufacturing and service industries. Moreover, the dataset conveys even information on the behavior of micro-sized firms with less than ten employees. Very small companies are always neglected by previous literature despite their great diffusion and the high potential benefits they can gain from international markets and GVC participation. Importantly, this is the first paper dealing with econometric issues by exploiting a panel dimension of the data, and quantifying the role of GVCs during the Lehman and sovereign debt crises.[6]

A further contribution of this work is our novel empirical identification of value chains and GVC forms of governance. The few empirical papers exploiting firm-level data either took for granted the involvement of all manufacturing companies in complex inter-firm connections (thus assuming that GVCs are economy-wide phenomena), or employed firms' exporting status and international sub-contracting as simple proxies for GVCs. Although firms' degree of interconnection experienced strong increases in the last decades, we regard the first assumption as very debatable, especially within developed countries with sizable domestic markets. The adoption of proxies for GVCs is the only feasible option, but we argue that the complexity of the phenomenon requires more sophisticated indicators for a precise identification of the value chains. In addressing this last issue, our approach relies on a rich dataset allowing to match information on the type of goods sold (intermediate or final), their destination markets (domestic or foreign), origin markets of the inputs purchased, and "length" of the inter-firm relationships (domestic or international). Furthermore, we propose a classification of GVC governance that allows for empirical tests on firms' upgrading propensity. In the spirit of the existing theoretical argumentations, we exploit information on firm degree of subordination

[6]The focus on the recent crisis may raise concerns on the out-of-sample validity of our results. In this regard, international evidence pointed out greater difficulties for GVC companies due to their higher elasticity to international trade (Escaith et al, 2010; see also Boehm et al, 2014, for the role of trade and multinational firms in the cross-country transmission of shocks). This is consistent with the findings of Burstein et al (2008); Bergin et al (2009); Ng (2010); Bergin et al (2011); Gangnes et al (2012), documenting higher business cycle correlations in countries with stronger GVC linkages. Our empirical approach partially controls for these heterogeneous shocks with the inclusion of firm-class specific time fixed effects (see section 3.3). Notice however, that this issue is likely to underestimate the overall effect of GVC participation, thus inducing an attenuation bias for our results.

and supplier capability to classify companies into arm-length, quasi-hierarchical, hierarchical, and relational GVCs. The specific focus on this last form of governance represents a relevant contribution of our paper, especially since most of the literature –typically analyzing LDCs characterized by a low diffusion of this modality– was not able to adequately test its role. We then exploit this classification to study several dimensions of upgrading based on both the extensive and intensive margins of innovation, R&D, and export activity, as well as productivity and sales growth.[7]

Also noteworthy, we explore effects that are over and above the mere impact of internationalization on firms' activity. This is made possible by an identification strategy allowing to control for firm international status and to purge export-driven factors from the GVC estimates.[8]

# 3 Empirical methodology

This section presents the empirical strategy of the paper. First, we describe our approach in identifying GVCs and their different forms of governance. We then illustrate the econometric methodology and the set of variables employed in the analysis.

## 3.1 Identification of GVCs

Exactly identifying firms in GVCs is an impossible task to accomplish on a large scale. The empirical papers dealing with micro data typically resorted to firms' international activity as an indicator for the involvement in value chains. This approach relies on strong assumptions and oversimplifies the very nature of GVCs; a complex phenomenon that can hardly be proxied by simple measures and requires a large amount of information to be properly identified. Our paper takes a step forward in this direction by providing a structured empirical definition of GVCs that possibly improves upon the traditionally used proxies.

Our identification strategy stems directly from the GVC literature and combines information on the

[7]Notice that the core of our paper moves the attention away from standard definitions of upgrading crudely based on increases in per-unit value of products (that may be the result of various forms of innovation but also of cost reductions). The main focus on direct indicators of firms' innovativeness, R&D, and export, allows for a richer (and precise) array of firms' upgrading strategies that does not leave room for misinterpretation. While innovations are a direct form of upgrading, R&D can be interpreted either as a type of functional upgrading or a necessary "upgrading channel". Similarly, firms' changes in the internationalization status can be viewed as a form of market upgrading. However, we also test the robustness of our results to alternative definitions of upgrading such as firms' value-added per worker and sales growth.

[8]On the other hand, previous papers on GVCs –employing simple proxies based on firm degree of internationalization– may suffer from confoundedness of the results linked to existence of learning-by-exporting effects.

type of good sold (intermediate or final), its destination market (domestic or foreign), the origin market of inputs purchased, and the existence/extension of stable inter-firm relationships (domestic or international networks). Firms are then classified into "stand alone", belonging to national value chains (NVC), or global value chains (GVC), according to the following matrix:

| | | **Type of good sold** | | | |
|---|---|---|---|---|---|
| | | **Intermediate** | | **Final** | |
| | | **Domestic** | **Export** | **Domestic** | **Export** |
| **Input purchased** | **Domestic** | NVC or GVC (if inter. netw.) (1) | GVC (2) | Stand alone or NVC (if dom. netw.) or GVC (if inter. netw.) (3) | Stand alone or NVC (if dom. netw.) or GVC (if inter. netw.) (4) |
| | **Import** | NVC or GVC (if inter. netw.) (5) | GVC (6) | Stand alone or NVC (if dom. netw.) or GVC (if inter. netw.) (7) | GVC (8) |

This scheme permits to identify the cells with the highest *a priori* likelihood of containing companies in a GVC.

The need of several levels of information is motivated by the great heterogeneity in the possible forms of participation in a value chain. Indeed, in the same economic scenario coexist companies that are completely integrated in a global dimension, firms whose international activity is only oriented toward the research of new markets (or input purchase) but that are not involved in GVCs, and companies that belong to a GVC even without any direct relationship with foreign enterprises (i.e., "long GVC").[9] Our approach based on multiple criteria helps disentangling this heterogeneity.

We first exploit information on the type of good sold, its destination market, and the origin market of the inputs purchased. Since intermediate goods are typically employed in broader productive processes, firms exporting semi-finished products can be reasonably thought to be part of a GVC (cells 2 and 6). Similarly, a company importing its inputs *and* exporting final goods is totally integrated in an international dimension

[9] A firm is said to be in a long value chain if it participates in the production process of a GVC without having any direct relationship with foreign companies. In other words, firms that are integrated in long GVCs contributes to the production process on a global scale, but have exclusively close interactions with domestic companies (that in turn will have connections at the supranational level). Notice that, while the common emphasis of the literature in on the opportunity of learning from global buyers, we also allow for indirect relationships in which knowledge transmissions may occur "a cascade" through learning from the closest (internationalized) domestic firm.

and is likely to be involved in a production on a global scale (cell 8). A certain degree of ambiguity arises when dealing with firms that are internationalized to some extent; either importing input factors *or* exporting final goods (cells 4, 5, and 7). In other words, a partial internationalization is compatible with firms that are links of a chain as well as stand alone companies whose international activity is only the result of strategic behaviors (searching for new markets or purchasing inputs at lower costs).

In order to disentangle this ambiguity and to account for the aforementioned possibility of long value chains, we further enrich our classification with information on global networks. The MET survey (see section 4 for further details) provides information on the existence of "stable and relevant direct or indirect relationships with foreign companies". We regard this as a necessary condition for belonging to a GVC. By exploiting this additional dimension, we are able to identify partially-internationalized companies that participate in GVCs (about 25% of the ambiguous cases in cells 4, 5, and 7) as well as domestic firms involved in long GVCs (10% of the domestic companies in cells 1 and 3).[10,11]

Similarly, firms are considered to belong to national value chains (NVC) if they sell intermediate goods on a local scale or declare to be part of domestic networks.[12] The excluded group is deemed to be composed by stand alone companies.

Finally, it is worth stressing again that our measure of GVC is not collinear with firm degree of internationalization, thus leaving room for controls aimed at disentangling the effect of GVC participation from export-driven factors.

## 3.2 Modes of participation in GVCs

Even if GVCs represent a fertile environment for upgrading, the extent to which knowledge is created and transferred among companies may vary considerably across their modes of participation in the chain, thus resulting in heterogeneous upgrading capacities for the firms involved. In order to test this proposition we group companies along different forms of GVC governance and explore upgrading differentials across groups.

[10]Notice that this classification is only feasible for manufacturing firms. Companies in the service sectors are defined to be part of a GVC if they belong to international networks, without any further information on the destination/origin markets. Results are however robust to the exclusion of service sectors from the sample.

[11]Throughout the paper we do not impose any lower bound to identify exporters. However, we also test the robustness of our results to the adoption of alternative measures obtained by imposing more conservative thresholds for firm exporting activity (25% or 40% of firm total sales).

[12]The MET survey also provides a question on the existence of "stable and relevant relationships with domestic companies".

The criterion proposed by Gereffi et al (2005) requires knowledge on firm specific measures of capacity as well as on the complexity and codifiability of the transactions. Since the latter are typically difficult to quantify, sector specific, and unavailable, we propose an alternative (but coherent) classification based upon two main factors: the capability of suppliers and the strength of the power relationships among the actors involved in the GVC.[13]

The first dimension has crucial implications for the learning prospects of a company. Firms in GVCs need some skills not only to handle the expertise they already have, but also to access external sources of knowledge (Cohen and Levinthal, 1989). Indeed, multinational companies are more willing to transfer knowledge to skilled partners (using it effectively within the GVC agreements) to reduce the risk of "residual incompatibilities" between the product design and the components manufactured (Puga and Trefler, 2010). Furthermore, capable firms are also more likely to be interested in participating knowledge-intense relationships because of the higher payoff they expect to earn from accessing external sources of knowledge. Finally, higher capabilities also imply a certain degree of autonomy creating incentives to stimulate efficiency gains, accumulation of technical skills, and investments in creative activities.

This last argumentation advances the need of a second discriminating factor, the existence of power relationships between firms involved in the GVC, to account for the lower learning opportunities experienced by strongly subordinated suppliers. Indeed, under the (legitimate or implicit) authority used to create and coordinate the division of labor along the chain, knowledge is typically treated as a scarce resource and concentrated in specialized functional units at the highest levels of the GVC. In this scenario, narrowly-specialized (subordinated) suppliers –albeit efficient for routine tasks– are less prone to undertake innovative activities because of their low levels of technological know-how and their few incentives to contribute with innovative ideas to transmit upward.

There are thus good reasons to argue that both suppliers' capability and the strength of the power relationships in place can strongly influence the coordination mechanisms among companies along the chain. This may heavily affect the extent to which knowledge transfers occur.

Our empirical approach exploits data on the affiliation to corporate groups, the existence of stable and

[13]Our classification is somehow in between the ones of Humphrey and Schmitz (2002) and Gereffi et al (2005).

relevant inter-firm relationships for commercial purposes, and the degree of participation in the conception of the final product to identify four main forms of GVC governance –namely *arm-length*, *quasi-hierarchical*, *hierarchical*, and *relational*– according to the following scheme:

1. *Arm-length*: suppliers without any stable and relevant commercial relationship with client firms.[14] They are the most "market-like" form of GVCs implying negligible reciprocal dependence between buyers and suppliers because of the high degree of codifiability of transaction involving the exchange of standard (or easily customized) goods whose requirements can be met by a broad range of firms.

2. *Hierarchical*: subsidiaries of corporate groups. The degree of subordination is maximum since they are typically managerially controlled by a parent company (which is often the leader of the chain).[15]

3. *Quasi-hierarchical*: companies with relevant and stable relationships with client firms, and no involvement in the conception of the final product.[16] Even in absence of a formal control by a lead firm, quasi-hierarchical suppliers are strongly dependent on buyers providing detailed specifications on goods and production processes.[17]

4. *Relational*: firms characterized by relevant stable relationships with client companies, and high degree of involvement in the definition of the final product.[18] Companies are typically involved in close inter-firm connections, but their high capability ensures greater degrees of autonomy compared to quasi-hierarchical relationships.[19]

We regard this classification to be potentially capable of revealing a high degree of heterogeneity in the upgrading propensity of firms in GVCs. First of all, we expect relatively-lower effects for hierarchical

[14]This information comes directly from the following question in the MET survey: "are there any stable and significant relationships with other companies for commercial purposes?".

[15]To derive this piece of data we match information on the affiliation to corporate groups with a dummy variable for parent companies (imposed equal to zero).

[16]The existence of commercial network is defined as in footnote 14, while firms' degree of involvement in the conception of the final product comes from the following question in the MET survey: "to what extent does your firm participate in the conception and definition of the final product for the market?". The survey allows answers on a scale from zero to four. Throughout the core of the paper, quasi-hierarchical suppliers are required to have no participation (0), but we also try alternative thresholds (1 or 2) with no significant changes in the results.

[17]In this regard, the existence of relevant commercial networks proxies for their strong dependence and subordination, while the absence of participation in the definition of the final product captures firms' low inner capability and marginal involvement in the decisional process at the GVC level (thus implying high control/monitoring by lead firms).

[18]Throughout the paper we simply require a positive threshold for firms' involvement in the conception of the final product. However, we also test the robustness of our results to the adoption of alternative thresholds (greater than 1 or 2), or different proxies for firm capability (share of graduated employees). For a detailed list of robustness checks see section 5.6.

[19]Also in this case, relevant commercial networks proxy for mutual dependence, while firms' high degree of participation in the conception of the final product captures the high capability of the supplier and its relevant involvement in the decisional process at the GVC level (thus implying a high degree of autonomy).

and quasi-hierarchical relationships where the existence of power relationships (and low capacity for the second mode) inhibits firms' incentives to innovate. *Vice versa*, because of the combination of low degree of subordination and high supplier capability, we trust relational GVCs to play a dominant role for firms' upgrading propensity. Finally, we have mixed *a priori* expectations on arm-length relationships. Indeed, while the absence of strong ties with other companies implies on the one hand a high degree of autonomy (thus fostering upgrading), on the other it also limits the possibility of knowledge exchanges with partner firms. In other words, it is possible that arm-length suppliers in a GVC have no upgrading premia compared to merely internationalized companies. Notice that our hypotheses are only partially compatible with the dominant literature on GVCs. This difference is mainly due to the definition of governance adopted, to our specific focus on developed countries (whose benchmark is composed of firms with higher average upgrading propensity), and to the absorption of export-driven effects.

From an empirical perspective it is worth emphasizing that the availability of repeated interviews implies an identification of GVC participation that is time varying. This variation has crucial importance for the GVC literature as well as for the identification of the effects of interest, allowing for the inclusion of firm-specific fixed effects aimed at purging the estimates from firms' unobservable heterogeneity.

### 3.3 Econometric approach

The econometric analysis employs the classification outlined in the previous sections to explore firms' upgrading processes within GVCs. We take into account several definitions of upgrading, based upon the extensive and intensive margins of innovation, R&D, and export activity (only relevant for firms in long value chains), as well as firms' productivity and sales growth. The baseline specification tests the existence of upgrading premia –in terms of extensive margins– for firms in global and national value chains, or analyzes heterogeneities across the different forms of GVC governance. The main estimation equation is of the type:

$$Pr(Y_{it} = 1) = \Phi\left(\alpha^{\top} VC_{it-1} + \beta^{\top} X_{it-1} + \lambda_{r,p,s}^{\top} + \lambda_t + c_i\right), \tag{1}$$

where $Y_{it}$ is a dichotomous dependent variable –either innovation, R&D, or export– and $VC_{it-1}$ is a vector of covariates measuring the beginning-of-period value-chain participation ($GVC_{it-1}$ and $NVC_{it-1}$) or form

of governance ($Arm\text{-}length_{it-1}$, $Quasi\text{-}hierarchy_{it-1}$, $Hierarchy_{it-1}$, and $Relational_{it-1}$).[20] The standard reduced form equation (1) includes a rich set of covariates ($X_{it-1}$) capturing structural (size, age, sales, cash flow, market share, share of final goods sold, vertical integration, productivity) and strategic characteristics (affiliation to networks or groups of firms, human capital, and R&D), as well as firms' exporting status.[21] The latter aims at purging the estimates from the mere effect of internationalization on firms' upgrading capacity. We also include time effects and controls for firms' industry (12), region (20), or geographical province (110) (namely $\lambda_t$ and $\lambda_{r,p,s}$) to capture common shocks that are time varying and permanent effects driven by the belonging sector or the geographical location of a company.[22] Finally, $c_i$ is a factor capturing firms' unobserved heterogeneity.

There are two main issues we have to take into account in assessing the effects of GVCs on firms' upgrading propensity. The first one has to do with reverse causality, whereby GVCs do not foster upgrading processes but instead are themselves the consequence of successful upgradings. The second interrelated point is linked to the possible self selection of more dynamic companies into GVCs.[23]

Since the adoption of external instruments is hardly feasible in our framework, we try to address these econometric issues in several alternative ways.[24] First of all, we alleviate problems of reverse causality by ruling out simultaneity bias. Matching current upgrading with lagged values of the GVC status partially solves reverse causation but may leave residual endogeneity if there is relevant unobserved heterogeneity or if the dependent variable and the participation in GVCs are highly persistent.

Dealing with unobserved heterogeneity in a binary-response framework is extremely delicate. On the

[20] Notice that a positive association between GVCs and export status is intrinsic in the very definition of GVCs. What is not trivial is whether firms that belong to long GVCs (i.e., not internationalized) in $t-1$, have a higher likelihood to upgrade and expand their activities abroad in time $t$. The rest of this section presents several approaches aimed at isolating this effect.

[21] To mitigate endogeneity issues all covariates are lagged once. However, we also propose specifications with further lags (L2 for survey measures and L3 for balance-sheet variables) with unchanged results. A detailed definition of the variables employed is provided in Appendix.

[22] Notice that if we did not control for $\lambda_{r,p,s}$, and if GVCs (or some specific forms of GVC governance) were predominantly diffused within industries or geographical areas characterized by higher upgrading propensities, our estimates would be upward biased because of the neglected industrial and geographical components. Instead, $\lambda_{r,p,s}$ purges common effects and allows for a cross-industry/cross-region comparison. Similarly, the time effects control for the possible correlation between GVC diffusion and unobserved shocks affecting the entire economy.

[23] Indeed, the existence of fixed sunk costs required to transmit product specifications, monitor and coordinate workers abroad (Melitz, 2003; Melitz et al, 2004) implies a higher likelihood of offshoring and export for more productive firms (typically, larger ones). This is confirmed by the well documented *ex ante* productivity gap between exporters and non-exporters (see Fabling and Sanderson, 2013 among others).

[24] Notice that even bilateral (or multilateral) agreements between Italy and other countries are not a suitable option in our scenario. Indeed, the identification of the participation in GVCs would require an instrument (possibly time-varying) providing a sufficient degree of cross-sectional variation. On the one hand, between 2008 and 2013 there were not enough interventions to allow the adoption of a diff-in-diff approach. On the other, pre-existent agreements were typically aimed at facilitating the overall international trade, thus not providing any cross-sectional heterogeneity in the effect (neither along the type of good traded, nor in terms of geographical/industrial location of the firm).

one hand, estimations of standard random-effects (RE) models impose unrealistic assumptions on the type of heterogeneity that takes place (i.e., $c_i$ must be uncorrelated with the entire set of regressors).[25] On the other, fixed-effects models (that do not impose any assumption on $c_i$) are computationally difficult and introduce an incidental parameter problem (when T is small) leading to inconsistent estimates. Our strategy is in-between the two approaches and relies on RE-probit models augmented with the time average of each regressor (i.e., "Mundlak-type controls"). This procedure relaxes the strong assumption of independence between $c_i$ and the set of covariates, and allows to estimate the effect of changes in the variables, holding their time average fixed.[26] Moreover, to further control for persistence of $Y_{it}$, we always provide results also on the subset of non-upgrading firms in $t-1$ (i.e., $Y_{it-1}=0$).[27]

In the unlikely scenario that residual heterogeneity is still affecting our findings, we also implement some alternative estimators compatible with the introduction of firm fixed effects. In section 5.3 we prove our results to be robust to conditional logistic and linear probability (within estimators) models allowing to capture all firms' (observable and unobservable) characteristics that are stable over time. Furthermore, we also employ two-step system-GMM models –on a synthetic measure of upgrading computed as the first principal component of R&D and of the various forms of innovation– instrumenting each variable with its own set of internal instruments. Notice that these approaches are all aimed at purging the possible selection of permanently more dynamic firms into GVCs.

Finally, we further take care of self selection by employing matching techniques (Coarsened Exact Matching techniques, Iacus et al, 2011) to recover a subsample of firms with the same *ex ante* probability of GVC participation (matched by age, size, region, industry, human capital, and productivity).[28] We then re-

[25] Let $\varepsilon_{it}$ be the error term and $Z$ be the full set of covariates (composed by $VC_{it-1}$ and $X_{it-1}$). RE models impose the strong hypothesis of independence between $c_i$ and the $Z_{it}$ (i.e., $E[c_i|Z]=0$, $cov[c_i,c_j|Z]=0$ if $i\neq j$, $cov[\varepsilon_{it},c_j|Z]=0\ \forall i,t,j$).

[26] Our estimator follows Wooldridge (2010) and can be thought as a Mundlak version of the Chamberlain's assumption on the correlation between $c_i$ and $Z$ $\left(i.e., c_i|Z\sim N(\psi+\bar{z}_i,\sigma_a^2)\right)$. Notice that this approach is equivalent to a fixed effects model in which the heterogeneity is projected on the time-mean of the regressors ($\bar{Z}_i$), allowing to write the latent variable as $Y_{it}^{*}=\psi+\beta^{\top}Z_{it-1}+\theta^{\top}\bar{Z}_i+e_{it}$, with $e_{it}\sim N(0,1)$. As usual, the estimator hinges crucially on the strict exogeneity of $Z_{it-1}$ conditional on $c_i$. We verify this hypothesis by adding the vector $Z_{it}$ to our specification and testing the significance of its estimates (as proposed by Wooldridge, 2010). The test never rejects the null (for any of the additional regressors), thus providing at least some justification for the strict exogeneity assumption.

[27] Notice that, when dealing with firms' exporting status, this permits to rule out the endogeneity introduced by the very empirical approach employed to identify GVCs. Focusing on non-exporters in $t-1$ is equivalent to explore the effect of long value chains (the only type of GVCs that is not excluded from the estimation sample) on firms' probability of exporting.

[28] Our choice to employ CEM rather than standard propensity-score matching techniques is driven by its appealing properties in the estimation of causal effects (by reducing imbalance in covariates between treated and control groups). Indeed, the monotonic imbalance bounding method reduces the maximum imbalance on one variable without affecting the others, does not require a separate procedure to restrict data to common support, meets the congruence principle, is approximately invariant to measurement error, balances all nonlinearities and interactions in-sample (i.e., not merely in expectation), and works with multiply imputed data sets (Blackwell et al, 2009). However, we also test the robustness of our results to the use of standard

estimate our baseline specification for the new subsample of "balanced firms" to make inference on the treatment effect and provide robustness to our results.

The last econometric issue that is worth discussing is the possibility of correlated shocks. In other words, if there is a polarization of GVCs (or certain forms of GVC governance) within specific industries or geographical areas, firms' upgrading strategies may result from the reaction to unobserved correlated shocks rather than from the propulsive role of GVCs.[29] To address this concern we enrich our baseline specifications with an extensive set of time fixed effects that are specific for firms' belonging industry (12 macro-industries $\times$ 3 periods), region ($20 \times 3$), and geographical province ($110 \times 3$).

The other estimations throughout the paper are variations upon the baseline specification (RE-tobit models with Mundlak's correction for the intensive margins and two-step system GMM estimators for productivity and sales growth) and are discussed in section 5.

# 4 Data

The main source of data is the MET database on Italian firms, the widest survey administrated in a single European country. The timing of the waves –2008, 2009, 2011, and 2013– allows to capture firms' behavior, performances, and strategies from the beginning of the Lehman turmoil until the end of the sovereign debt crisis.[30] The sample is selected and stratified in order to guarantee representativeness at size, geographical region and industry levels (see Table 1 for some details). The dataset contains roughly 25,000 firms per wave, referring to both manufacturing (60%) and service industries (40%). The MET surveys contain a rich array of information including the type of goods sold and destination market, the type of input purchased and origin market, the existence and extension of inter-firm networks, the affiliation to corporate groups, the involvement in the conception of the final product, as well as information on innovation, R&D, human capital, export, and several other firm-level characteristics.

Survey data are then matched with balance sheet information from CRIBIS D&B.

From the original dataset the application of selection-filters produces a relevant contraction in the sample

matching techniques with qualitatively similar findings.

[29] This is the case if the two financial crises induced differential effects across industries and regions.

[30] Each questionnaire asks for firms' situation at the end of the previous year.

Table 1: Sample composition of the MET surveys

| | 2008 | 2009 | 2011 | 2013 |
|---|---|---|---|---|
| Micro (1-9) | 38.4% | 60.0% | 61.6% | 48.1% |
| Small (10-49) | 38.4% | 26.0% | 24.7% | 33.6% |
| Medium (50-249) | 19.5% | 10.4% | 10.6% | 13.5% |
| Large (>250) | 3.60% | 3.50% | 3.10% | 4.80% |
| North | 46.6% | 39.8% | 42.1% | 40.2% |
| Center | 32.0% | 33.7% | 31.8% | 30.5% |
| South | 21.4% | 26.5% | 26.1% | 29.3% |
| High-tech | 33.5% | 29.1% | 31.1% | 31.9% |
| Non High-tech | 66.5% | 70.9% | 68.9% | 68.1% |
| # of firms | 24896 | 22340 | 25090 | 25000 |

*Notes*: composition of the sample by firm size class (number of employees), geographical macro-region, and industrial macro-sector (high-tech sectors are considered: chemicals, plastic, means of transportation, engineering, electric and electronic equipment). The original sample is mainly stratified along 12 industries, 20 regions, and four size classes. The large amount of interviews is compatible with an oversampling of more innovative firms in the manufacturing sector, and of companies in certain geographical regions. The oversampling scheme is performed with Bayesian models exploiting the observed frequencies of the previous waves. The survey is administrated via phone calls or via web with the assistance of a phone operator. The actual administration follows a preselection of the most suitable answerer. In the case of incoherent answers along the survey, firms are interviewed a second time as an additional control of validity. For further details about the sampling scheme, the administration methods, and the control procedures see Brancati (2012).

size. The major reduction comes from the focus (for econometric purposes) on companies in the panel with complete balance-sheet information.[31] In addition, some observations are dropped because of unreasonable values (negative or nil assets, negative or nil sales) or to reduce the influence of outliers (balance sheet variables are censored at 1%). Depending on the specification, the final estimation sample ranges from 30,000 to 10,000 observations.

## 4.1 Descriptive statistics

Table 2 presents summary statistics for the main variables employed. Overall, 20% the firms in the sample belong to our definition of GVC (employing roughly 40% of the total labor force in Italy):[32] 29% are relational suppliers, while arm-length, quasi-hierarchical, and hierarchical relationships are 30%, 28%, and 14%, respectively. They also display quite a heterogeneous distribution across industries, with a prominent diffusion within the chemical, electronic, engineering, and textile sectors (Table 3).

Table 4 reports conditional statistics for innovation and R&D. Firms belonging to GVCs display higher propensities of upgrading, with shares of dynamic companies that are two-to-four times larger than non-GVC firms. This phenomenon is strongly heterogeneous across forms of governance and is mainly driven by the

[31] Balance sheet data are not available for family firms, a relevant fraction of the overall sample. This constraint, combined with the need of longitudinal data, induces a sample reduction of about 60%.

[32] As expected, the share of workers employed by GVC firms is significantly lower than that of previous studies on LDCs.

Table 2: Descriptive statistics.

| Variable | Type | Mean | Std. | Min | Max |
|---|---|---|---|---|---|
| GVC | Dummy | 0.197 | 0.397 | 0.000 | 1.000 |
| NVC | Dummy | 0.254 | 0.435 | 0.000 | 1.000 |
| Arm-length | Dummy | 0.059 | 0.235 | 0.000 | 1.000 |
| Quasi-hierarchy | Dummy | 0.055 | 0.227 | 0.000 | 1.000 |
| Hierarchy | Dummy | 0.025 | 0.157 | 0.000 | 1.000 |
| Relational | Dummy | 0.058 | 0.234 | 0.000 | 1.000 |
| Innovation | Dummy | 0.302 | 0.459 | 0.000 | 1.000 |
| Export | Dummy | 0.240 | 0.427 | 0.000 | 1.000 |
| R&D | Dummy | 0.150 | 0.357 | 0.000 | 1.000 |
| Prod_P | Dummy | 0.140 | 0.347 | 0.000 | 1.000 |
| Prod_S | Dummy | 0.129 | 0.335 | 0.000 | 1.000 |
| Proc | Dummy | 0.149 | 0.356 | 0.000 | 1.000 |
| %(Prod_P) | Bounded | 0.045 | 0.172 | 0.000 | 1.000 |
| %(Prod_S) | Bounded | 0.032 | 0.135 | 0.000 | 1.000 |
| %(R&D) | Bounded | 0.009 | 0.051 | 0.000 | 2.500 |
| %(Exp) | Bounded | 0.101 | 0.213 | 0.000 | 1.000 |
| Log-productivity | Continuous | 10.51 | 1.105 | -0.654 | 17.32 |
| Log-sales | Continuous | 14.74 | 1.636 | 10.35 | 18.87 |
| Size | Continuous | 2.441 | 1.399 | 0.693 | 10.72 |
| Age | Continuous | 2.704 | 0.933 | 0.000 | 7.607 |
| Sales | Continuous | 1.145 | 0.787 | 0.000 | 4.365 |
| Cash flow | Continuous | 0.024 | 0.106 | -0.389 | 0.410 |
| Market share | Bounded | 0.029 | 0.070 | 0.000 | 0.496 |
| Vertical integration | Continuous | 0.268 | 0.280 | 0.000 | 0.951 |
| Network | Dummy | 0.367 | 0.482 | 0.000 | 1.000 |
| Group | Dummy | 0.134 | 0.340 | 0.000 | 1.000 |
| Human capital | Bounded | 0.076 | 0.173 | 0.000 | 1.000 |

*Notes:* descriptive statistics for the main variables employed. All measures are defined in Appendix.

Table 3: Global value chain participation across industries.

| Industry | NVC | GVC | Arm-length | Hierarchy | Quasi-hierarchy | Relational |
|---|---|---|---|---|---|---|
| Food | 22.6% | 15.2% | 4.02% | 1.25% | 3.61% | 6.13% |
| Textile | 24.1% | 26.2% | 8.98% | 2.71% | 6.64% | 7.91% |
| Furniture | 23.7% | 16.2% | 5.54% | 0.73% | 4.14% | 5.73% |
| Printing | 29.3% | 14.8% | 4.24% | 1.44% | 4.79% | 4.27% |
| Chemical | 22.9% | 38.3% | 11.6% | 7.16% | 9.90% | 9.67% |
| Machinery | 27.6% | 22.0% | 6.05% | 2.42% | 6.91% | 6.61% |
| Transportation | 23.1% | 29.5% | 8.58% | 5.57% | 6.96% | 8.41% |
| Engineering | 26.9% | 31.3% | 9.43% | 5.09% | 7.58% | 9.17% |
| Electric | 23.3% | 37.2% | 11.1% | 6.14% | 8.58% | 11.4% |
| Mineral | 28.1% | 15.5% | 4.98% | 1.55% | 4.32% | 4.57% |
| Transports | 26.7% | 15.6% | 4.21% | 1.06% | 7.12% | 3.22% |
| Services | 28.4% | 10.6% | 2.83% | 1.46% | 3.01% | 3.28% |

*Notes:* participation in GVC and GVC governance by industrial sector. All measures are defined in Appendix.

higher dynamism of relational suppliers.

The aim of the next section is to assess whether behind this positive association there a causal nexus linking GVCs, supplier capability, and firms' upgrading propensity.

Table 4: Conditional upgrading propensities.

| | Innovation | R&D |
|---|---|---|
| Non GVC | 18.9% | 9.67% |
| GVC | 41.1% | 36.8% |
| Arm-length | 39.1% | 14.9% |
| Quasi-hierarchy | 31.4% | 21.5% |
| Hierarchy | 30.6% | 26.6% |
| Relational | 43.1% | 39.8% |

*Notes:* percentage of innovative firms (column 1) and companies with R&D projects (column 2) conditionally on their participation in GVCs and on GVC forms of governance. All measures are defined in Appendix.

# 5 Results

This section presents the results of the paper. First, we analyze the effect of GVC participation on firms' probability of innovation and R&D. We then explore heterogeneities by GVC forms of governance and discuss the results for the intensive margins, as well as for productivity and sales growth.

## 5.1 GVC participation and firms' upgrading

Table 5 presents the results for the baseline specification on the extensive margins of innovation. Firms belonging to GVCs display an innovative propensity that is 4%-to-6% higher than national value chains (not significant) and stand alone companies (our benchmark). This effect is robust to the inclusion of a rich set of covariates; from simple controls for firms' structural characteristics (column 1), to an extensive series of strategic behaviors (R&D, network and corporate group belonging, human capital, and export) and industrial/geographical fixed effects (columns 2 and 3).

It is worth noting that our estimates are obtained netting out the higher average innovative propensity of companies involved in GVCs ($\mu$(GVC) in Table 5) as well as other relevant persistent heterogeneities. In other words, the inclusion of Mundlak-type regressors (time average of every independent variable) allows to purge the model from most unobservable factors and to focus on effects that are only driven by the time variation of the covariates.[33]

In order to account for the possible reverse causality driven by persistence of firms' innovativeness,

[33]Notice that the significance of most of the estimates of the regressor means (also the ones that are not showed) validates our need of relaxing the assumptions of standard RE probit models.

columns 4–6 present the estimates for the subsample of non-innovative companies in $t-1$ ($Y_{it-1}=0$). Also in this case, GVC participation is found to significantly foster firms' innovative propensity (6.4% increase in the richest specification of column 6).

Table 5: GVC participation and firms' innovativeness.

| | Y: Innovation$_t$ | | | | | |
|---|---|---|---|---|---|---|
| Sample: | Entire | | | Innovation$_{t-1}=0$ | | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| GVC$_{t-1}$ | 0.053*** | 0.037*** | 0.040*** | 0.090*** | 0.067*** | 0.064*** |
| | [0.014] | [0.014] | [0.015] | [0.022] | [0.020] | [0.020] |
| NVC$_{t-1}$ | 0.018* | 0.010 | 0.017 | 0.021 | 0.020 | 0.019 |
| | [0.010] | [0.009] | [0.010] | [0.017] | [0.017] | [0.017] |
| Size$_{t-1}$ | 0.032*** | 0.024*** | 0.025*** | 0.053*** | 0.044*** | 0.044*** |
| | [0.008] | [0.007] | [0.008] | [0.008] | [0.008] | [0.008] |
| Age$_{t-1}$ | 0.006 | 0.031 | 0.075 | 0.013 | 0.048 | 0.046 |
| | [0.045] | [0.046] | [0.063] | [0.047] | [0.046] | [0.046] |
| Sales$_{t-1}$ | -0.035*** | -0.022*** | -0.019*** | -0.011** | -0.003 | -0.003 |
| | [0.004] | [0.004] | [0.005] | [0.005] | [0.005] | [0.005] |
| Cash flow$_{t-1}$ | 0.159*** | 0.119*** | 0.122** | 0.072 | 0.050 | 0.054 |
| | [0.042] | [0.040] | [0.055] | [0.051] | [0.046] | [0.046] |
| Market share$_{t-1}$ | 0.015 | 0.004 | 0.004 | -0.013 | -0.019 | -0.017 |
| | [0.021] | [0.021] | [0.021] | [0.032] | [0.033] | [0.034] |
| Vertical integration$_{t-1}$ | 0.001 | -0.004 | -0.018 | 0.023 | 0.019 | 0.019 |
| | [0.017] | [0.015] | [0.018] | [0.017] | [0.016] | [0.016] |
| R&D$_{t-1}$ | | 0.279*** | 0.272*** | | 0.188*** | 0.181*** |
| | | [0.007] | [0.010] | | [0.010] | [0.010] |
| Network$_{t-1}$ | | 0.064*** | 0.059*** | | 0.092*** | 0.093*** |
| | | [0.009] | [0.010] | | [0.008] | [0.008] |
| Group$_{t-1}$ | | 0.042*** | 0.046*** | | 0.003 | 0.003 |
| | | [0.012] | [0.013] | | [0.011] | [0.011] |
| Human capital$_{t-1}$ | | | 0.018 | | | 0.047*** |
| | | | [0.019] | | | [0.017] |
| Export$_{t-1}$ | | | 0.078*** | | | 0.041*** |
| | | | [0.011] | | | [0.009] |
| Controls | | | | | | |
| Time | yes | yes | yes | yes | yes | yes |
| Industry(12) | yes | yes | yes | yes | yes | yes |
| Region(20) | yes | yes | no | yes | yes | no |
| Province (110) | no | no | yes | no | no | yes |
| Mundlak's correction | yes | yes | yes | yes | yes | yes |
| $\mu$(GVC) | 0.072*** | 0.065*** | 0.054*** | 0.008 | -0.009 | -0.017 |
| $\mu$(NVC) | -0.008 | -0.007 | -0.010 | -0.063 | -0.047 | -0.048 |
| # obs. | 29754 | 29754 | 29754 | 13172 | 13172 | 13172 |
| Pseudo-R$^2$ | 0.076 | 0.142 | 0.144 | 0.085 | 0.150 | 0.153 |

*Notes:* marginal effects from RE-probit models with Mundlak's correction. The dependent variable is *Innovation*. The left panel reports the estimates for the entire sample, while the right panel refers to subset of non-innovative firms in $t-1$. Additional covariates in the estimations (not shown): time average of each regressor. All measures are defined in Appendix. *, **, *** denote, respectively, significance at 10%, 5%, and 1% level. Robust standard errors in brackets.

The other controls present sensible coefficients too. In line with *a priori* expectations structural characteristics play a critical role in affecting firm innovativeness, with large companies characterized by a higher likelihood of introducing innovations. As expected, firm innovative propensity heavily reacts to the

availability of internal funds (cash flow), to the presence of R&D projects, and to international trade (via learning-by-exporting effects). Moreover, the affiliation to corporate groups have a positive impact on firms' probability of innovating, but belonging to "informal networks" plays an even more important role. The other estimates have ambiguous signs and are not robust along different specifications adopted.

Table 6 presents coherent results for the extensive margins of R&D. Firms involved in GVCs show greater dynamic propensities, translating into a probability of undertaking R&D projects that is 4%-to-7% higher that stand alone companies. Interestingly, national value chains seem to display relevant dynamic attitudes too (albeit lower than GVCs), but this effect tends to vanish once controlling for strategic attitudes and for the persistence of the dependent variable. Importantly, the effect of GVC participation is over and above the positive (and significant) impact of firm degree of internationalization (last row of Tables 5 and 6).

## 5.2 Heterogeneities by GVC forms of governance

Once shown the higher upgrading propensity of firms in GVCs, we explore heterogeneities across the different forms of governance. Theoretical literature suggests that the mere participation in GVCs is not sufficient for a company's upgrading, that instead is related to firm own way to operate within the chain. In particular, we regard relational GVCs as the ideal environment for upgrading because of the combined low subordination and high level of competences required to manage knowledge flows. We empirically test this statement by enriching the baseline specification with the definitions of governance outlined in section 3.2.

Table 7 presents the estimates for firms' innovativeness. Results clearly show that the effect of GVC participation on the probability of introducing innovations is far from being homogeneous and strictly depends upon the type of relationship in place. Coherently with theoretical predictions, suppliers involved in relational GVCs display a degree of innovativeness that is 3%-to-7% higher than non-GVC companies.[34] These effects statistically dominate other forms of governance (not significant), and are robust to the inclusion of controls for firms' dynamic attitudes (R&D, human capital, and export activity) as well as for the persistence of the dependent variable (columns 4–6). Importantly, further analyses on the type of improvement undertaken (not shown) highlight stronger effects on "radical" product innovations (products that are new

[34] We also tried to classify NVCs by different forms of governance. Since their estimates are again never statistically different from zero, our choice throughout the rest of the paper is to focus only on GVCs, interpreting the estimated coefficients as deviations from stand alone companies and NVCs (our new benchmark).

Table 6: GVC participation and firms' investment in R&D.

| | Y: $R\&D_t$ | | | | | |
|---|---|---|---|---|---|---|
| Sample: | Entire | | | $R\&D_{t-1} = 0$ | | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $GVC_{t-1}$ | 0.044*** | 0.043*** | 0.030** | 0.074*** | 0.073*** | 0.067*** |
| | [0.012] | [0.012] | [0.013] | [0.016] | [0.016] | [0.016] |
| $NVC_{t-1}$ | 0.022** | 0.021** | 0.017 | 0.013 | 0.013 | 0.011 |
| | [0.010] | [0.010] | [0.011] | [0.011] | [0.011] | [0.011] |
| $Size_{t-1}$ | 0.027*** | 0.027*** | 0.023*** | 0.035*** | 0.035*** | 0.035*** |
| | [0.008] | [0.008] | [0.008] | [0.006] | [0.006] | [0.006] |
| $Age_{t-1}$ | -0.080** | -0.083** | -0.108** | -0.032 | -0.033 | -0.042 |
| | [0.039] | [0.039] | [0.044] | [0.033] | [0.033] | [0.034] |
| $Sales_{t-1}$ | -0.036*** | -0.035*** | -0.033*** | -0.015*** | -0.015*** | -0.014*** |
| | [0.004] | [0.004] | [0.005] | [0.004] | [0.004] | [0.004] |
| Cash $flow_{t-1}$ | 0.104*** | 0.104*** | 0.089* | 0.036 | 0.036 | 0.041 |
| | [0.046] | [0.046] | [0.041] | [0.043] | [0.043] | [0.042] |
| Market $share_{t-1}$ | 0.010 | 0.007 | 0.008 | 0.002 | 0.001 | 0.007 |
| | [0.014] | [0.014] | [0.015] | [0.017] | [0.017] | [0.018] |
| Vertical $integration_{t-1}$ | 0.019 | 0.019 | 0.019 | 0.035** | 0.035** | 0.034** |
| | [0.015] | [0.015] | [0.015] | [0.014] | [0.014] | [0.014] |
| $Network_{t-1}$ | | 0.038*** | 0.059*** | | 0.067*** | 0.068*** |
| | | [0.008] | [0.010] | | [0.009] | [0.008] |
| $Group_{t-1}$ | | 0.028*** | 0.006 | | 0.010 | 0.002 |
| | | [0.007] | [0.010] | | [0.009] | [0.009] |
| Human $capital_{t-1}$ | | | 0.231*** | | | 0.148*** |
| | | | [0.023] | | | [0.014] |
| $Export_{t-1}$ | | | 0.119*** | | | 0.044*** |
| | | | [0.009] | | | [0.007] |
| Controls | | | | | | |
| Time | yes | yes | yes | yes | yes | yes |
| Industry(12) | yes | yes | yes | yes | yes | yes |
| Region(20) | yes | yes | no | yes | yes | no |
| Province (110) | no | no | yes | no | no | yes |
| Mundlak's correction | yes | yes | yes | yes | yes | yes |
| $\mu$(GVC) | 0.140*** | 0.140*** | 0.088*** | 0.019 | 0.019 | 0.005 |
| $\mu$(NVC) | 0.015 | 0.016 | 0.013 | -0.036** | -0.036** | -0.036** |
| # obs. | 29754 | 29754 | 29754 | 14953 | 14953 | 14953 |
| Pseudo-$R^2$ | 0.144 | 0.156 | 0.212 | 0.109 | 0.112 | 0.134 |

*Notes:* marginal effects from RE-probit models with Mundlak's correction. The dependent variable is *R&D*. The left panel reports the estimates for the entire sample, while the right panel refers to subset of firms with no R&D projects in $t-1$. Additional covariates in the estimations (not shown): time average of each regressor. All measures are defined in Appendix. *, **, *** denote, respectively, significance at 10%, 5%, and 1% level. Robust standard errors in brackets.

for the market) rather than imitative products and new production processes.

Table 8 presents the results for firms' investment in R&D. Once again, the higher average degree of dynamism highlighted in the previous section (Table 6) hides relevant heterogeneities across forms of GVC governance. Coherently with our previous findings, highly-competent relational suppliers have a probability of undertaking R&D projects that is 4%-to-7% higher than non-GVC companies, while the effects of other forms of governance are, again, not statistically significant (in column 6).

The last form of strategic upgrading analyzed is related to firms' degree of internationalization. While

Table 7: GVC forms of governance and firms' innovativeness.

| | Y: Innovation$_t$ | | | | | |
|---|---|---|---|---|---|---|
| Sample: | Entire | | | Innovation$_{t-1}=0$ | | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Arm-length$_{t-1}$ | -0.012 | -0.013 | -0.016 | 0.002 | 0.006 | 0.003 |
| | [0.012] | [0.017] | [0.011] | [0.017] | [0.018] | [0.016] |
| Quasi-hierarchy$_{t-1}$ | 0.020 | 0.026 | 0.020 | 0.030 | 0.027 | 0.021 |
| | [0.013] | [0.019] | [0.013] | [0.019] | [0.019] | [0.019] |
| Hierarchy$_{t-1}$ | 0.017 | -0.011 | -0.012 | -0.005 | -0.011 | -0.011 |
| | [0.020] | [0.030] | [0.020] | [0.031] | [0.032] | [0.030] |
| Relational$_{t-1}$ | 0.053*** | 0.042*** | 0.034*** | 0.072*** | 0.057*** | 0.058*** |
| | [0.011] | [0.016] | [0.011] | [0.015] | [0.016] | [0.015] |
| Controls | | | | | | |
| Time | yes | yes | yes | yes | yes | yes |
| Industry(12) | yes | yes | yes | yes | yes | yes |
| Region(20) | yes | yes | no | yes | yes | no |
| Province (110) | no | no | yes | no | no | yes |
| Mundlak's correction | yes | yes | yes | yes | yes | yes |
| $\mu$(Arm-length) | 0.041** | 0.031* | 0.028* | 0.057** | 0.048** | 0.041* |
| $\mu$(Quasi-hierarchy) | -0.001 | -0.009 | -0.024 | -0.032 | -0.032 | -0.041 |
| $\mu$(Hierarchy) | 0.022 | -0.001 | -0.005 | 0.010 | 0.008 | 0.002 |
| $\mu$(Relational) | 0.087*** | 0.021 | 0.009 | 0.043 | 0.001 | -0.012 |
| # obs. | 29754 | 29754 | 29754 | 13172 | 13172 | 13172 |
| Pseudo-R$^2$ | 0.079 | 0.143 | 0.145 | 0.091 | 0.153 | 0.156 |

*Notes:* marginal effects from RE-probit models with Mundlak's correction. The dependent variable is *Innovation*. The left panel reports the estimates for the entire sample, while the right panel refers to subset of non-innovative firms in $t-1$. Additional covariates in the estimations (not shown) follow the specifications of Table 5. All measures are defined in Appendix. *, **, *** denote, respectively, significance at 10%, 5%, and 1% level. Robust standard errors in brackets.

Table 8: GVC forms of governance and firms' investment in R&D.

| | Y: R&D$_t$ | | | | | |
|---|---|---|---|---|---|---|
| Sample: | Entire | | | R&D$_{t-1}=0$ | | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Arm-length$_{t-1}$ | 0.009 | 0.009 | 0.010 | 0.004 | 0.004 | 0.001 |
| | [0.010] | [0.010] | [0.010] | [0.014] | [0.014] | [0.013] |
| Quasi-hierarchy$_{t-1}$ | 0.009 | 0.008 | -0.001 | 0.032* | 0.032* | 0.017 |
| | [0.013] | [0.013] | [0.012] | [0.017] | [0.017] | [0.015] |
| Hierarchy$_{t-1}$ | 0.013 | -0.003 | -0.005 | -0.019 | -0.033 | -0.034 |
| | [0.013] | [0.014] | [0.014] | [0.024] | [0.024] | [0.024] |
| Relational$_{t-1}$ | 0.050*** | 0.047*** | 0.036*** | 0.075*** | 0.072*** | 0.056*** |
| | [0.011] | [0.011] | [0.010] | [0.014] | [0.014] | [0.013] |
| Controls | | | | | | |
| Time | yes | yes | yes | yes | yes | yes |
| Industry(12) | yes | yes | yes | yes | yes | yes |
| Region(20) | yes | yes | no | yes | yes | no |
| Province (110) | no | no | yes | no | no | yes |
| Mundlak's correction | yes | yes | yes | yes | yes | yes |
| $\mu$(Arm-length) | 0.019 | 0.023 | 0.002 | 0.003 | 0.005 | 0.001 |
| $\mu$(Quasi-hierarchy) | 0.038*** | 0.044*** | 0.010 | -0.004 | 0.003 | -0.004 |
| $\mu$(Hierarchy) | 0.015 | 0.007 | 0.001 | -0.005 | -0.008 | -0.013 |
| $\mu$(Relational) | 0.168*** | 0.166*** | 0.118*** | 0.077*** | 0.079*** | 0.063*** |
| # obs. | 29754 | 29754 | 29754 | 14953 | 14953 | 14953 |
| Pseudo-R$^2$ | 0.164 | 0.180 | 0.195 | 0.126 | 0.145 | 0.158 |

*Notes:* marginal effects from RE-probit models with Mundlak's correction. The dependent variable is *R&D*. The left panel reports the estimates for the entire sample, while the right panel refers to subset of firms with no R&D projects in $t-1$. Additional covariates in the estimations (not shown) follow the specifications of Table 6. All measures are defined in Appendix. *, **, *** denote, respectively, significance at 10%, 5%, and 1% level. Robust standard errors in brackets.

Table 9: Participation in long GVCs, forms of governance, and firms' exporting status.

| | Y: Export$_t$ | | | | | |
|---|---|---|---|---|---|---|
| Sample: | | | | Export$_{t-1}=0$ | | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| GVC$_{t-1}$ | 0.183*** | 0.183*** | 0.182*** | | | |
| | [0.013] | [0.013] | [0.013] | | | |
| Arm-length$_{t-1}$ | | | | 0.137*** | 0.135*** | 0.132*** |
| | | | | [0.016] | [0.017] | [0.017] |
| Quasi-hierarchy$_{t-1}$ | | | | 0.145*** | 0.151*** | 0.151*** |
| | | | | [0.018] | [0.018] | [0.018] |
| Hierarchy$_{t-1}$ | | | | 0.056* | 0.052* | 0.052* |
| | | | | [0.031] | [0.031] | [0.031] |
| Relational$_{t-1}$ | | | | 0.172*** | 0.178*** | 0.179*** |
| | | | | [0.015] | [0.015] | [0.015] |
| Controls | | | | | | |
| Time | yes | yes | yes | yes | yes | yes |
| Industry(12) | yes | yes | yes | yes | yes | yes |
| Region(20) | yes | yes | no | yes | yes | no |
| Province (110) | no | no | yes | no | no | yes |
| Mundlak's correction | yes | yes | yes | yes | yes | yes |
| $\mu$(GVC) | 0.491*** | 0.505*** | 0.497*** | – | – | – |
| $\mu$(Arm-length) | – | – | – | 0.433*** | 0.411*** | 0.408*** |
| $\mu$(Quasi-hierarchy) | – | – | – | 0.334*** | 0.348*** | 0.344*** |
| $\mu$(Hierarchy) | – | – | – | -0.089*** | -0.102*** | -0.098*** |
| $\mu$(Relational) | – | – | – | 0.359*** | 0.374*** | 0.369*** |
| # obs. | 11603 | 11603 | 11603 | 11603 | 11603 | 11603 |
| Pseudo-R$^2$ | 0.452 | 0.455 | 0.461 | 0.462 | 0.466 | 0.470 |

*Notes:* marginal effects from RE-probit models with Mundlak's correction. The dependent variable is *Export*. Both the left and right panels report the estimates for the subset of non-exporter firms in $t-1$. Additional covariates in the estimations (not shown): time average of each regressor, *Size*, *Age*, *Sales*, *Cash flow*, *Market share*, *Vertical integration*, *Network* (only in columns 2, 3, 5, and 6), *Group* (only in columns 2, 3, 5, and 6), and *Human capital* (only in columns 3 and 6) All measures are defined in Appendix. *, **, *** denote, respectively, significance at 10%, 5%, and 1% level. Robust standard errors in brackets.

the positive association between GVCs and exporting status is induced by construction, our sample also includes companies involved in long GVCs (roughly 5%). This gives the opportunity to study whether the insertion in a global production process also encourages domestic companies to search for an international dimension. In other words, we ask whether the participation of local firms in GVCs, through the exchange of soft information (with partners along the chain) that helps overcoming the informational opaqueness of international markets, stimulates a different form of upgrading achieved with the penetration into new markets.

Table 9 answers this question by presenting results for the subsample of non-exporters in $t-1$. Firms participating in long GVCs (the only type of GVCs that is left in the estimation) have a probability of exporting that is roughly 20% higher than non-GVC companies, with an effect that is almost homogeneous across the different forms of governance. This evidence suggests that, even if the form of governance dramatically affects firms' innovative upgrading, the mere affiliation to GVCs may still produce significant effects

in terms of market upgrading.

### 5.3 Unrestricted unobserved heterogeneity

The estimators proposed so far control for unobserved heterogeneity by conditioning $c_i$ on the full set of regressors' means. We further take care of unobservable factors in several alternative ways.

First, we employ linear probability models explicitly allowing for the inclusion of firm and time fixed effects without any restriction on the type of unobserved heterogeneity. Table 10 presents results that are largely coherent with previous findings and show a greater innovative propensity for firms in relational GVCs (3%-to-5% higher).[35]

Our results are also robust to the adoption of conditional logistic models with firm and time fixed effects. Even with a very reduced sample size (because of the exclusive use within-firm differences), Table 11 presents coefficients that are broadly in line with our previous findings, suggesting they are not driven by residual unobserved heterogeneity.

Finally, we construct a synthetic measure of upgrading employing the first principal component of R&D and of the different forms of innovations (loading positively on each factor and accounting for 45% of the total variance). In addition to standard fixed-effect models (within estimator), the different nature of the dependent variable also allows for a dynamic specification via two-step system-GMM (Arellano and Bover, 1995; Blundell and Bond, 1998) with Windmeijer finite-sample correction of the standard errors. The estimator combines the original equation (in level) with its transformed version in first differences, accounting for heteroskedasticity and autocorrelation within firms in a small-T, large-N unbalanced panel. All possibly endogenous (and predetermined) variables are instrumented with appropriately-lagged levels in the differenced equation and with their first differences in the level equation. Once again results are unaffected suggesting they are driven neither by residual unobserved heterogeneity, nor by endogeneity of our GVC forms of governance.[36]

[35] Differently from previous results, Table 10 also shows a lower propensity for quasi-hierarchical GVCs in undertaking R&D projects.

[36] Indeed, the Arellano-Bond test of second-order serial correlation of the error term indicates that values lagged twice of more are legitimate instruments for our possibly endogenous variables. Moreover, the Hansen J-test does not detect any misspecification of the estimated model.

Table 10: GVC forms of governance and firms' upgrading: linear probability models.

| Y: | Innovation$_t$ | | R&D$_t$ | | Export$_t$ | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Arm-length$_{t-1}$ | 0.002 | -0.010 | 0.015* | 0.004 | 0.076*** | 0.078*** |
| | [0.009] | [0.009] | [0.008] | [0.008] | [0.009] | [0.009] |
| Quasi-hierarchy$_{t-1}$ | -0.002 | -0.002 | -0.021** | -0.030*** | 0.135*** | 0.141*** |
| | [0.0107] | [0.0103] | [0.008] | [0.008] | [0.011] | [0.011] |
| Hierarchy$_{t-1}$ | 0.024 | 0.0197 | 0.009 | 0.008 | 0.036** | 0.032* |
| | [0.017] | [0.0161] | [0.013] | [0.013] | [0.017] | [0.017] |
| Relational$_{t-1}$ | 0.045*** | 0.026*** | 0.036*** | 0.027*** | 0.141*** | 0.140*** |
| | [0.009] | [0.008] | [0.013] | [0.007] | [0.009] | [0.009] |
| Fixed effects | | | | | | |
| Time | yes | yes | yes | yes | yes | yes |
| Firm | yes | yes | yes | yes | yes | yes |
| # obs. | 18801 | 18801 | 18801 | 18801 | 18801 | 18801 |
| $R^2$ | 0.078 | 0.164 | 0.095 | 0.145 | 0.410 | 0.429 |
| F stat | 81.7*** | 143.7*** | 60.08*** | 62.91*** | 62.11*** | 64.1*** |

*Notes:* estimates from linear probability models with time and firm fixed effects (within estimators). The dependent variables are *Innovation* in columns 1 and 2, *R&D* in columns 3 and 4, and *Export* in columns 5 and 6. Additional covariates in the estimations (not shown) follow the specifications in column 1 (for odd columns) and 3 (for even columns) of Table 7, 8, and 9 (except for Munldak-type regressors). All measures are defined in Appendix. *, **, *** denote, respectively, significance at 10%, 5%, and 1% level. Standard errors in brackets.

Table 11: GVC forms of governance and firms' upgrading: conditional FE logit models.

| Y: | Innovation$_t$ | | R&D$_t$ | | Export$_t$ | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Arm-length$_{t-1}$ | 0.271 | 0.253 | 0.324 | 0.463 | 0.805 | 0.680 |
| | [0.256] | [0.272] | [0.334] | [0.337] | [0.535] | [0.556] |
| Quasi-hierarchy$_{t-1}$ | 0.382 | 0.301 | -0.640* | -0.583 | 2.508*** | 2.680*** |
| | [0.295] | [0.308] | [0.378] | [0.379] | [0.671] | [0.690] |
| Hierarchy$_{t-1}$ | 0.332 | 0.372 | -0.197 | -0.468 | 1.565** | 1.689** |
| | [0.415] | [0.467] | [0.476] | [0.512] | [0.665] | [0.831] |
| Relational$_{t-1}$ | 0.646*** | 0.439* | 0.648** | 0.675** | 3.230*** | 3.322*** |
| | [0.224] | [0.241] | [0.277] | [0.279] | [0.645] | [0.675] |
| Fixed effects | | | | | | |
| Time | yes | yes | yes | yes | yes | yes |
| Firm | yes | yes | yes | yes | yes | yes |
| # obs. | 2507 | 2504 | 1595 | 1592 | 7949 | 7889 |

*Notes:* estimates from conditional logistic models with time and firm fixed effects. The dependent variables are *Innovation* in columns 1 and 2, *R&D* in columns 3 and 4, and *Export* in columns 5 and 6. Additional covariates in the estimations (not shown) follow the specifications in column 1 (for odd columns) and 3 (for even columns) of Table 7, 8, and 9 (except for Munldak-type regressors). All measures are defined in Appendix. *, **, *** denote, respectively, significance at 10%, 5%, and 1% level. Standard errors in brackets.

## 5.4 Intensive margins of innovation, R&D, and export

Previous findings clearly document the higher upgrading propensity of GVC firms, especially of highly-skilled relational suppliers. This section addresses a closely related question by analyzing the impact on the intensive margins of innovation, R&D, and export. In other words, we explore whether GVC participation affects both probability *and* magnitude of firms' upgrading, or instead has effects that are limited to the

Table 12: GVC forms of governance and firms' upgrading: principal component.

| | Y: PC(upgrading)$_t$ | | |
|---|---|---|---|
| Technique: | Within estimator | | System GMM |
| | (1) | (2) | (3) |
| Arm-length$_{t-1}$ | 0.019 | 0.022 | -0.0102 |
| | [0.039] | [0.040] | [0.0604] |
| Quasi-hierarchy$_{t-1}$ | 0.063 | 0.057 | 0.0359 |
| | [0.043] | [0.043] | [0.0686] |
| Hierarchy$_{t-1}$ | 0.045 | 0.042 | 0.135 |
| | [0.064] | [0.065] | [0.133] |
| Relational$_{t-1}$ | 0.126*** | 0.118*** | 0.213*** |
| | [0.036] | [0.036] | [0.072] |
| Controls | | | |
| Time | yes | yes | yes |
| Firm FE | yes | yes | yes |
| # obs. | 18798 | 18798 | 18798 |
| $R^2$ | 0.099 | 0.102 | – |
| F stat. | 62.34*** | 60.56*** | – |
| Hansen p-value | – | – | 0.235 |
| AR(1) p-value | – | – | 0.000 |
| AR(2) p-value | – | – | 0.689 |

*Notes:* estimates from within estimator (columns 1 and 2) and two-step system-GMM (column 3) models with firm and time fixed effects. The dependent variable *PC(upgrading)* is the first principal component of *R&D*, *Prod_P*, *Prod_S*, and *Proc.* (explaining 45% of the total variance and loading positively on each factor, albeit with decreasing magnitude of the eigenvalues) and represents a synthetic measure of upgrading. Additional covariates in the estimations (not shown) follow the specifications in Table 6 (column 3, except for Munldak-type regressors). Column 2 and 3 also include lagged values of the dependent variable. In column 3 all variables are instrumented with their lagged (2 and 3) levels in the differenced equation, and with their first difference in the level equation. *Hansen p-value* reports the p-value of the Hansen J test of overidentifying restrictions. *AR(q) p-value* denotes the Arellano and Bond (1991) test of $q^{th}$ order serial correlation. All measures are defined in Appendix. *, **, *** denote, respectively, significance at 10%, 5%, and 1% level. Robust standard errors in brackets (with Windmeijer finite-sample correction in column 3).

extensive margins.

To this purpose, we re-estimate equation (1) on a new set of dependent variables capturing the intensive margins of upgrading. We proxy the intensity of innovation with two alternative variables: the share of sales from products that are innovative for the market (capturing the weight of radical product innovations, namely *%(Prod_P)*), and the share of sales from products that are innovative only for the firm (and not for the market, capturing softer forms of improvements such as imitative products, *%(Prod_S)*). Similarly, we proxy R&D intensity with firms' expenditure in R&D projects (as a share of total sales, *%(R&D)*), and export intensity as the share of sales from exported products (*%(Exp)*).

Table 13 reports synthetic results from random-effect tobit models with Mundlak's correction. The estimates are mostly coherent with our previous findings. Not only GVC participation fosters firms' probability of introducing innovations, but has also effects on the magnitude of the innovation introduced. Once again, the heterogeneity across forms of governance highlights a dominant role for relational suppliers, and no sig-

nificant impact for the other forms of GVCs. Importantly, the effect is stronger for the introduction of truly innovative products (column 1, 5) than for softer innovations such as the imitative ones (column 2, 6). This higher dynamic attitude is confirmed also for firms' investment in R&D (column 3 and 7).

Finally, GVC participation also boosts the degree of international opening through strong and positive impact on firms' export activity. Again, this effect is found to be more homogeneous across forms of GVC governance –exept for hierarchical suppliers– and to persists even for the subset of previously non-internationalized companies (belonging to long GVCs, column 8).

Table 13: GVC forms of governance and firms' upgrading: intensive margins.

| Sample: | Entire | | | | $Y_{t-1} = 0$ | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Y: | $\%(\text{Prod\_P})_t$ | $\%(\text{Prod\_S})_t$ | $\%(\text{R\&D})_t$ | $\%(\text{Exp})_t$ | $\%(\text{Prod\_P})_t$ | $\%(\text{Prod\_S})_t$ | $\%(\text{R\&S})_t$ | $\%(\text{Exp})_t$ |
| Arm-length$_{t-1}$ | 3.366 | 3.342 | 1.870*** | 7.546*** | 3.521 | -0.802 | 2.372*** | 11.68*** |
| | [2.738] | [2.264] | [0.570] | [0.745] | [3.839] | [3.338] | [0.783] | [1.287] |
| Quasi-hierarchy$_{t-1}$ | 3.752 | -1.061 | -0.692 | 8.283*** | 11.34*** | 5.621 | -0.739 | 11.88*** |
| | [3.112] | [2.607] | [0.587] | [0.803] | [4.261] | [3.948] | [0.920] | [1.562] |
| Hierarchy$_{t-1}$ | 3.174 | -7.527** | -1.174 | 3.396*** | 6.099 | -12.47** | -0.865 | 0.748 |
| | [4.182] | [3.238] | [0.799] | [1.245] | [6.288] | [5.461] | [1.265] | [2.499] |
| Relational$_{t-1}$ | 6.558*** | 3.549* | 1.383*** | 9.043*** | 6.344** | 7.072*** | 2.413*** | 13.69*** |
| | [2.269] | [1.854] | [0.461] | [0.668] | [3.180] | [2.677] | [0.654] | [1.266] |
| Controls | | | | | | | | |
| Time | yes | yes | yes | yes | yes | yes | yes | yes |
| Industry(12) | yes | yes | yes | yes | yes | yes | yes | yes |
| Region(20) | yes | yes | yes | yes | yes | yes | yes | yes |
| Province (110) | yes | yes | yes | yes | yes | yes | yes | yes |
| Mundlak's correction | yes | yes | yes | yes | yes | yes | yes | yes |
| $\mu$(Arm-length) | 1.334 | 1.831 | -0.0497 | 18.52*** | 3.687 | 18.03*** | -1.445 | 30.37*** |
| $\mu$(Quasi-hierarchy) | 3.539 | 3.019 | 3.700*** | 38.85*** | -6.811 | -4.111 | 2.190 | 43.87*** |
| $\mu$(Hierarchy) | -3.068 | 9.530** | 3.019** | 3.171* | 3.126 | 4.057 | 0.0525 | 10.61** |
| $\mu$(Relational) | 34.82*** | 21.93*** | 9.261*** | 42.77*** | 37.33*** | 19.06*** | 7.279*** | 45.16*** |
| # obs. | 26515 | 26515 | 26504 | 29756 | 13576 | 13576 | 14285 | 11484 |

*Notes:* estimates from RE-tobit models with Mundlak's correction. The dependent variables are listed in the top row: *%(Prod_P)* in column 1 and 5, *%(Prod_S)* in column 2 and 6, *%(R&D)* in column 3 and 7, *%(Exp)* in column 4 and 8. Left panels report the estimates for the entire sample, while right panels refer to subset of firms for which $Y_{t-1} = 0$. Additional covariates in the estimations (not shown) follow the specifications in column 3 of Table 7 (for columns 1, 2, 5, 6), Table 8 (for columns 3, 7), and Table 9 (for columns 4, 8). All measures are defined in Appendix. *, **, *** denote, respectively, significance at 10%, 5%, and 1% level. Robust standard errors in brackets.

## 5.5 Effects on productivity and sales growth

Once assessed the impact of GVC participation on firms' upgrading strategies, we take a step forward and analyze the real effects on productivity and sales growth. As in section 5.3 we adopt a dynamic specification through two-step system-GMM models.

Even controlling for previous realizations of the dependent variables, for structural and strategic charac-

Table 14: GVC participation, forms of governance, productivity, and sales growth.

| Y: | Log-productivity$_t$ | | Log-sales$_t$ | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| GVC$_{t-1}$ | 0.0950* | | 0.0883*** | |
| | [0.0526] | | [0.0276] | |
| Arm-length$_{t-1}$ | | -0.105 | | -0.0182 |
| | | [0.157] | | [0.0237] |
| Quasi-hierarchy$_{t-1}$ | | 0.190 | | 0.0423 |
| | | [0.138] | | [0.0300] |
| Hierarchy$_{t-1}$ | | -0.718** | | -0.0398 |
| | | [0.325] | | [0.0377] |
| Relational$_{t-1}$ | | 0.267*** | | 0.0495*** |
| | | [0.084] | | [0.0141] |
| Fixed effects | | | | |
| Time | yes | yes | yes | yes |
| Firm | yes | yes | yes | yes |
| # obs. | 7578 | 7578 | 7578 | 7578 |
| Hansen p-value | 0.217 | 0.159 | 0.292 | 0.411 |
| AR(1) p-value | 0.000 | 0.000 | 0.000 | 0.000 |
| AR(2) p-value | 0.271 | 0.311 | 0.675 | 0.698 |

*Notes:* estimates from two-step system-GMM models with time and firm fixed effects. The dependent variables are *Log-productivity* in columns 1 and 2, and *Log-sales* in columns 3 and 4. All measures are defined in Appendix. All variables are instrumented with their lagged (2 and 3) levels in the differenced equation, and with their first difference in the level equation. *Hansen p-value* reports the p-value of the Hansen J test of overidentifying restrictions. *AR(q) p-value* denotes the Arellano and Bond (1991) test of $q^{th}$ order serial correlation. *, **, *** denote, respectively, significance at 10%, 5%, and 1% level. Standard errors with Windmeijer finite-sample correction in brackets.

teristics that are time varying, common shocks, and stable firm-specific factors, GVC participation is found to affect both productivity and sales growth.[37] This effect is stronger for firms' productivity (as defined by the log-value added per worker)[38] than total revenues, and is mainly confined to relational suppliers (characterized by a 26%-higher productivity and a sales growth that is roughly 5% greater than other companies).[39] The other forms of GVC governance are again not statistically significant, suggesting that supplier capability plays a critical role in fostering productivity gains and economic performance.

## 5.6 Additional robustness

We run a number of additional robustness tests to check the validity of our results, mainly aimed at further exploring reverse causality, self selection, and the possibility of unobserved shocks.

- We allow the dependent variable to display an AR(1) process in equation (1). This approach provides

[37] Once again the Arellano-Bond test of second-order serial correlation and the Hansen J-test do not detect any misspecification of the model.

[38] We also tried to perform the analysis on firms' TFP as an alternative measure for productivity. Results are mostly coherent, albeit not always significant.

[39] Notice that, even if the dependent variable is in log-level, controlling for previous realizations of $Y_{it}$ allows to interpret the other estimates as partial effects on the growth rate.

consistent results and rules out any further endogeneity issue driven by the persistence of innovation and R&D.

- We employ a mixed strategy relying on matching techniques to further explore the issue of self selection. First we exploit Coarsened Exact Matching models (CEM: Iacus et al, 2011) to select a subsample of firms with the same *ex ante* probability of belonging to GVCs (the treatment variable).[40] We then repeat the analyses of section 5 on the new balanced sample. Our results still indicate higher upgrading propensities for GVC firms, especially for relational suppliers.

- We include time effects that are specific for firms' belonging industry (12×3), region (20×3), and province (110×3) to control for unobservable correlated shocks. Results are qualitatively unaffected.

- We implement multivariate probit models (with Mundlak's correction) to control for third party factors affecting at the same time firms' innovativeness, R&D propensity, and export status. This approach accounts for the simultaneity of the phenomena allowing for a correlation across the error terms of the three equations. Results are similar to the ones presented.

- We put to test alternative definitions of GVCs obtained by imposing more conservative thresholds for firm export activity (25% or 40% of firm total sales). We also try different measures of relational and quasi-hierarchical suppliers by choosing higher values of firm involvement in the conception of the final product, or the (median and $75^{th}$ percentile) share of graduated employees as alternative proxy for firm capability. In all cases results are largely unchanged.[41]

- Results are robust to the exclusion from the estimation sample of the service sectors or firms in long GVCs.

- We adopt alternative clustering of the standard errors (industry, region –with bootstrapping techniques–, or province, as well as two-way clustering at the industry-region and firm-industry levels). Statistical

[40] Firms are matched along the following characteristics: age, size, region, industry, human capital, and productivity.

[41] We also propose a classification in line with the existent literature. The hierarchical, quasi-hierarchical, and relational forms of governance are comparable to the ones of Gereffi et al (2005) (whose concept of captive GVCs is in line with quasi-hierarchical relationships). In order to split arm-length into *market* and *modular* GVCs we employ the share of turnover from subcontracted products (above median for modular relationships). Once again results are qualitatively unaffected. In particular, unlike most of the existent literature, we find no significant effects for modular suppliers. This difference may be driven either by our focus on developed countries, or by the inclusion of controls for firm degree of internationalization.

significance of the estimates is roughly unchanged.[42]

- Additional robustness checks are related to the enrichment of the matrix $X_{it-1}$ with: further lags for control variables (lagging survey measures twice and balance-sheet variables three times),[43] alternative definitions of firms' size (log of total assets), alternative measures for R&D and export in Table 7 ($\%(R\&D)_{t-1}$, share of employees devoted to R&D projects, and $\%(Exp)_{t-1}$), controls for the legal form of the company (partnerships, cooperatives, and enterprises), for firms' productivity (defined as log-value added per worker, or TFP as computed by Levinsohn and Petrin, 2003), and financial status (leverage and composition of funding). In all cases results still hold.

# 6 Concluding remarks

This paper takes advantage of the recent GVC framework to further explore the link between internationalization and firm performance. We ask whether firms' way to participate in the global production process affects their learning opportunities and upgrading strategies.

Our analysis exploits up-to-date survey data containing information on a large sample of Italian SMEs, including micro-sized companies with less than ten employees. The empirical strategy of the paper exploits the richness of the MET database and provides a novel approach to identify GVCs and their form of governance. Our identification classifies four modes of GVC participation –based on supplier capabilities and degree of subordination– matching information on the type and destination markets of the goods sold, the type and origin markets of the inputs purchased, the existence and length of inter-firm relationships, the affiliation to corporate groups, and firms' degree of involvement in the conception of the final product. We then analyze the impact of GVC participation on firms' innovativeness, investment in R&D, export, performance, and productivity.

Our findings provide empirical support to the existence of upgrading premia for firms in GVCs (over and above the mere effect of internationalization), translating into a degree of innovativeness that is 4%-to-7% higher than stand-alone companies and enterprises in national value chains. These effects are very heteroge-

[42] Notice that, because of the weighting matrix used in the second step, alternative clustering also produces changes in the estimates of the two-step system-GMM models. Results are however consistent with the ones presented in the previous section.

[43] Their aim is to reduce possible endogeneity issues linked to the main control variables employed.

neous across forms of GVC governance, being mainly confined to highly-capable (relational) suppliers. We interpret this evidence as the combined role played by chain connections and firms' capacity in accessing, handling, and absorbing external sources of knowledge.

The analysis provides coherent effects along several definitions of upgrading capacity, ranging from the extensive and intensive margins of innovation, R&D, and export, to outcome measures such as productivity and sales growth. Finally, our results are stable across a rich set of robustness checks controlling for possible reverse causality, self selection, persistence of the phenomena of interest, and even for firm observable and unobservable heterogeneity.

# References


Accetturo A, Giunta A, Rossi S (2011) The Italian firms between crisis and the new globalization. Bank of Italy Occasional Papers 86, DOI 10.2139/ssrn.1849865

Agostino M, Giunta A, Nugent J, Scalera D, Trivieri F (2014) The importance of being a capable supplier: Italian industrial firms in global value chains. International Small Business Journal (forthcoming) DOI 10.1177/0266242613518358

Altenburg T (2006) Governance patterns in value chains and their development impact. European Journal of Development Research 18(4):498–521, DOI 10.1080/09578810601070795

Amighini A, Rabellotti R (2006) How do Italian footwear industrial districts face globalization? European Planning Studies 14(4):485–502, DOI 10.1080/09654310500421105

Antràs P, Chor D (2013) Organizing the global value chain. Econometrica 81(6):2127–2204, DOI 10.3982/ECTA10813

Arellano M, Bond S (1991) Some tests of specification for panel data: Montecarlo evidence and application to employment equations. Review of Economic Studies 58:277–297, DOI 10.2307/2297968

Arellano M, 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

Aw BY, Chen X, Roberts M (2001) Firm-level evidence on productivity differentials and turnover in Taiwanese manufacturing. Journal of Development Economics 66(1):51–86, DOI 10.1016/S0304-3878(01)00155-9

Bair J, Gereffi G (2001) Local clusters in global chains: The causes and consequences of export dynamism in Torreon's blue jeans industry. World Development 29(11):1885–1903, DOI 10.1016/S0305-750X(01)00075-4

Bair J, Gereffi G (2003) Upgrading, uneven development, and jobs in the North American apparel industry. Global Networks 3(2):143–169, DOI 10.1111/1471-0374.00054

Baldwin J, Yan B (2014) Global value chains and the productivity of Canadian manufacturing firms. Economic Analysis (EA) Research Paper Series 90

Baldwin R, Venables AJ (2013) Spiders and snakes: Offshoring and agglomeration in the global economy. Journal of International Economics 90(2):245–254, DOI 10.1016/j.jinteco.2013.02.005

Bazan L, Navas-Alemán L (2004) The underground revolution in the Sinos Valley: A comparison of upgrading in global and national value chains. Local Enterprises in the Global Economy: Issues of Governance and Upgrading 3:110–139, DOI 10.4337/9781843769743.00012

Bergin P, Feenstra R, Hanson G (2009) Offshoring and volatility: Evidence from Mexico's maquiladora industry. American Economic Review 99(4):1664–1671, DOI 10.1257/aer.99.4.1664

Bergin P, Feenstra R, Hanson G (2011) Volatility due to offshoring: Theory and evidence. Journal of International Economics 85(2):163–173, DOI 10.1016/j.jinteco.2011.08.001

Bernard A, Jensen B (1999) Exceptional exporter performance: Cause, effect, or both? Journal of International Economics 47(1):1–25, DOI 10.1016/S0022-1996(98)00027-0

Bernard A, Wagner J (2001) Export entry and exit by German firms. Weltwirtschaftliches Archiv 137(1):105–123, DOI 10.1007/BF02707602

Bernard A, Eaton J, Jenson B, Kortum S (2003) Plants and productivity in international trade. American Economic Review 93(4):1268–1290, DOI 10.1257/000282803769206296

Blackwell M, Iacus S, King G, Porro G (2009) CEM: Coarsened exact matching in Stata. Stata Journal 9(4):524–546, DOI 10.1.1.214.9894

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

Boehm C, Flaaen A, Pandalai N (2014) Input linkages and the transmission of shocks: Firm-level evidence from the 2011 Tōhoku earthquake. Mimeo

Borrus M, Ernst D, Haggard S, et al (2003) International production networks in Asia: Rivalry or riches. Routledge, DOI 10.4324/9780203361115

Brancati R (2012) Crisi Industriale e Crisi Fiscale. Rapporto MET 2012. Le Relazioni delle Imprese, le Criticitá, il Fisco e le Politiche Pubbliche. Meridiana Libri

Burstein A, Kurz C, Tesar L (2008) Trade, production sharing, and the international transmission of business cycles. Journal of Monetary Economics 55(4):775–795, DOI 10.1016/j.jmoneco.2008.03.004

Castellani D, Zanfei A (2007) Internationalisation, innovation and productivity: How do firms differ in Italy? World Economy 30(1):156–176, DOI 10.1111/j.1467-9701.2007.00875.x

Chamberlain G (1980) Analysis of covariance with qualitative data. Review of Economic Studies 47(1):225–238, DOI 10.2307/2297110

Chiarvesio M, Di Maria E (2009) Internationalization of supply networks inside and outside clusters. International Journal of Operations & Production Management 29(11):1186–1207, DOI 10.1108/01443570911000186

Chiarvesio M, Di Maria E, Micelli S (2010) Global value chains and open networks: The case of Italian industrial districts. European Planning Studies 18(3):333–350, DOI 10.1080/09654310903497637

Clerides S, Lach S, Tybout J (1998) Is learning by exporting important? Micro-dynamic evidence from Colombia, Mexico, and Morocco. Quarterly Journal of Economics 113:903–947, DOI 10.1162/003355398555784

Cohen W, Levinthal D (1989) Innovation and learning: The two faces of R&D. Economic Journal 99:569–596, DOI 10.2307/2233763

Delgado M, Farinas J, Ruano S (2002) Firm productivity and export markets: A non-parametric approach. Journal of International Economics 57(2):397–422, DOI 10.1016/S0022-1996(01)00154-4

Dolan C, Humphrey J (2000) Governance and trade in fresh vegetables: The impact of UK supermarkets on the African horticulture industry. Journal of Development Studies 37(2):147–176, DOI 10.1080/713600072

Escaith H, Lindenberg N, Miroudot S (2010) International supply chains and trade elasticity in times of global crisis. World Trade Organization (Economic Research and Statistics Division) Staff Working Paper ERSD-2010-08 DOI 10.2139/ssrn.1548424

Evgeniev E, Gereffi G (2008) Textile and apparel firms in Turkey and Bulgaria: Exports, local upgrading and dependency. Economic Studies 17(3):148–179

Fabling R, Sanderson L (2013) Exporting and firm performance: Market entry, investment and expansion. Journal of International Economics 89(2):422–431, DOI 10.1016/j.jinteco.2012.08.008

Fernandez-Stark K, Bamber P, Gereffi G (2011) The offshore services value chain: Upgrading trajectories in developing countries. International Journal of Technological Learning, Innovation and Development 4(1):206–234, DOI 10.1504/IJTLID.2011.041905

Gangnes B, Ma A, Van Assche A (2012) Global value chains and the transmission of business cycle shocks. Asian Development Bank Discussion Paper 329, DOI 10.2139/ssrn.2127450

Gereffi G (1994) The organization of buyer-driven global commodity chains: How US retailers shape overseas production networks. Contributions in Economics and Economic History pp 95–95

Gereffi G (1999) International trade and industrial upgrading in the apparel commodity chain. Journal of International Economics 48(1):37–70, DOI 10.1016/S0022-1996(98)00075-0

Gereffi G, Frederick S (2010) The global apparel value chain, trade and the crisis: Challenges and opportunities for developing countries. World Bank Working Paper 5281, DOI 10.1596/1813-9450-5281

Gereffi G, Kaplinsky R (2001) The value of value chains: Spreading the gains from globalisation. Institute of Development Studies Bulletin 32:1–8

Gereffi G, Korzeniewicz M (1994) Commodity chains and global capitalism. ABC-CLIO 149, DOI 10.1016/j.jeconom.2004.02.005

Gereffi G, Humphrey J, Sturgeon T (2005) The governance of global value chains. Review of International Political Economy 12(1):78–104, DOI 10.1080/09692290500049805

Ghironi F, Melitz M (2005) International trade and macroeconomic dynamics with heterogeneous firms. Quarterly Journal of Economics 120(3):865–915, DOI 10.1162/003355305774268246

Giovannetti G, Marvasi E, Sanfilippo M (2015) Supply chains and the internalization of SMEs: Evidence from Italy. Small Business Economics (forthcoming), DOI 10.1007/s11187-014-9625-x

Girma S, Greenaway A, Kneller R (2004) Does exporting increase productivity? A microeconometric analysis of matched firms. Review of International Economics 12(5):855–866, DOI 10.1111/j.1467-9396.2004.00486.x

Giuliani E, Pietrobelli C, Rabellotti R (2005) Upgrading in global value chains: Lessons from Latin American clusters. World Development 33(4):549–573, DOI 10.1016/j.worlddev.2005.01.002

Giunta A, Nifo A, Scalera D (2012) Subcontracting in Italian industry: Labour division, firm growth and the North–South divide. Regional Studies 46(8):1067–1083, DOI 10.1080/00343404.2011.552492

Hallward-Driemeier M, Iarossi G, Sokoloff K (2002) Exports and manufacturing productivity in East Asia: A comparative analysis with firm-level data. NBER Working Paper 8894, DOI 10.3386/w8894

Head K, Ries J (2003) Heterogeneity and the FDI versus export decision of Japanese manufacturers. Journal of the Japanese and International Economies 17(4):448–467, DOI 10.1016/j.jjie.2003.09.003

Henderson J, Dicken P, Hess M, Coe N, Yeung HWC (2002) Global production networks and the analysis of economic development. Review of International Political Economy 9(3):436–464, DOI 10.1080/09692290210150842

Hummels D, Ishii J, Yi KM (2001) The nature and growth of vertical specialization in world trade. Journal of International Economics 54(1):75–96, DOI 10.1016/S0022-1996(00)00093-3

Humphrey J (2003) Globalization and supply chain networks: The auto industry in Brazil and India. Global Networks 3(2):121–141, DOI 10.1111/1471-0374.00053

Humphrey J, Schmitz H (2002) How does insertion in global value chains affect upgrading in industrial clusters? Regional Studies 36(9):1017–1027, DOI 10.1080/0034340022000022198

Iacus S, King G, Porro G (2011) Causal inference without balance checking: Coarsened exact matching. Political Analysis 20:1–24, DOI 10.1093/pan/mpr013

Kannegiesser M (2008) Value chain management in the chemical industry: Global value chain planning of commodities. Springer, DOI 10.1007/978-3-7908-2032-4

Kaplinsky R (2004) Spreading the gains from globalization: What can be learned from value-chain analysis? Problems of Economic Transition 47(2):74–115, DOI 10.1080/10611991.2004.11049908

Kraay A (2006) Exports and economic performance: Evidence from a panel of Chinese enterprises. Global Integration and Technology Transfer, Washington DC: The World Bank pp 139–160, DOI 10.4337/9781843765523.00019

Levinsohn J, Petrin A (2003) Estimating production functions using inputs to control for unobservables. Review of Economic Studies 70(2):317–341, DOI 10.1111/1467-937X.00246

Melitz M (2003) The impact of trade on intra-industry reallocations and aggregate industry productivity. Econometrica 71(6):1695–1725, DOI 10.1111/1468-0262.00467

Melitz M, Helpman E, Yeaple S (2004) Export versus FDI with heterogeneous firms. American Economic Review 94:300–316, DOI 10.1257/000282804322970814

Morrison A, Pietrobelli C, Rabellotti R (2008) Global value chains and technological capabilities: A framework to study learning and innovation in developing countries. Oxford Development Studies 36(1):39–58, DOI 10.1080/13600810701848144

Mundlak Y (1978) On the pooling of time series and cross section data. Econometrica 46(1):69–85, DOI 10.2307/1913646

Navas-Alemán L (2011) The impact of operating in multiple value chains for upgrading: The case of the Brazilian furniture and footwear industries. World Development 39(8):1386–1397, DOI 10.1016/j.worlddev.2010.12.016

Ng E (2010) Production fragmentation and business-cycle comovement. Journal of International Economics 82(1):1–14, DOI 10.1016/j.jinteco.2010.06.002

OECD (2013) Interconnected Economies: Benefiting from Global Value Chains. OECD Publishing, DOI 10.1787/9789264189560-en

Pavcnik N (2002) Trade liberalization, exit, and productivity improvements: Evidence from Chilean plants. Review of Economic Studies 69(1):245–276, DOI 10.1111/1467-937X.00205

Pietrobelli C, Rabellotti R (2011) Global value chains meet innovation systems: Are there learning opportunities for developing countries? World Development 39(7):1261–1269, DOI 10.1016/j.worlddev.2010.05.013

Pietrobelli C, Saliola F (2008) Power relationships along the value chain: Multinational firms, global buyers and performance of local suppliers. Cambridge Journal of Economics 32(6):947–962, DOI 10.1093/cje/ben016

Puga D, Trefler D (2010) Wake up and smell the ginseng: International trade and the rise of incremental innovation in low-wage countries. Journal of Development Economics 91(1):64–76, DOI 10.1016/j.jdeveco.2009.01.011

Saliola F, Zanfei A (2009) Multinational firms, global value chains and the organization of knowledge transfer. Research Policy 38(2):369–381, DOI 10.1016/j.respol.2008.11.003

Schmitz H (1999) Global competition and local cooperation: Success and failure in the Sinos Valley, Brazil. World Development 27(9):1627–1650, DOI 10.1016/S0305-750X(99)00075-3

Schmitz H (2004) Local enterprises in the global economy: Issues of governance and upgrading. Edward Elgar Publishing, DOI 10.4337/9781843769743.00020

Sturgeon T (2002) Modular production networks: A new American model of industrial organization. Industrial and Corporate Change 11(3):451–496, DOI 10.1093/icc/11.3.451

Sturgeon T, Florida R (2004) Globalization, deverticalization, and employment in the motor vehicle industry. Locating global advantage: Industry dynamics in the international economy pp 52–81

Sturgeon T, Kawakami M (2010) Global value chains in the electronics industry: Was the crisis a window of opportunity for developing countries? World Bank

Sturgeon T, Memedovic O (2010) Mapping global value chains: Intermediate goods trade and structural change in the world economy. Development Policy and Strategic Research Branch Working Paper 05

Sturgeon T, Van Biesebroeck J (2010) Effects of the crisis on the automotive industry in developing countries: A global value chain perspective. The World Bank: Policy Research Papers 5330, DOI 10.1596/1813-9450-5330

Sturgeon T, Van Biesebroeck J, Gereffi G (2008) Value chains, networks and clusters: Reframing the global automotive industry. Journal of Economic Geography 8:297–321, DOI 10.1093/jeg/lbn007

Sturgeon T, Memedovic O, Van Biesebroeck J, Gereffi G (2009) Globalisation of the automotive industry: Main features and trends. International Journal of Technological Learning, Innovation and Development 2(1):7–24, DOI 10.1504/IJTLID.2009.021954

Van Biesebroeck J (2005) Exporting raises productivity in sub-Saharan African manufacturing firms. Journal of International Economics 67(2):373–391, DOI 10.1016/j.jinteco.2004.12.002

Vind I, Fold N (2007) Multi-level modularity vs. hierarchy: Global production networks in Singapore's electronics industry. Geografisk Tidsskrift-Danish Journal of Geography 107(1):69–83, DOI 10.1080/00167223.2007.10801376

Wagner J (2007) Exports and productivity: A survey of the evidence from firm-level data. World Economy 30(1):60–82, DOI 10.1111/j.1467-9701.2007.00872.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 JM (2010) Econometric analysis of cross section and panel data. MIT press

Yeaple S (2005) A simple model of firm heterogeneity, international trade, and wages. Journal of International Economics 65(1):1–20, DOI 10.1016/j.jinteco.2004.01.001

# Appendix: variable definition

| Variable name | Definition |
|---|---|
| $\text{GVC}_{t-1}$ | dummy identifying global value chains in $t-1$. |
| $\text{NVC}_{t-1}$ | dummy identifying national value chains in $t-1$.[a] |
| $\text{Arm-length}_{t-1}$ | dummy identifying arm-length suppliers in $t-1$. |
| $\text{Quasi-hierarchy}_{t-1}$ | dummy identifying quasi-hierarchical suppliers in $t-1$. |
| $\text{Hierarchy}_{t-1}$ | dummy identifying hierarchical suppliers in $t-1$. |
| $\text{Relational}_{t-1}$ | dummy identifying relational suppliers in $t-1$.[b] |
| $\text{Innovation}_t$ | dummy identifying firms introducing at least one innovation in $t$ (independently by the type). |
| $\text{Export}_t$ | dummy identifying exporter firms in $t$. |
| $\text{R\&D}_t$ | dummy identifying firms that performed R&D activity in $t$ |
| $\%(\text{Prod\_P})_t$ | share of sales (in $t$) from products that are innovative for the market (radical product innovations). |
| $\%(\text{Prod\_S})_t$ | share of sales (in $t$) from products that are innovative for the firm but not for the market (imitative product innovations). |
| $\%(\text{R\&D})_t$ | $\text{R\&D expenditure}_{it}/\text{total sales}_{it}$. |
| $\%(\text{Exp})_t$ | $\text{sales from exported products}_{it}/\text{total sales}_{it}$. |
| $\text{Size}_{t-1}$ | $\ln(1+\text{employees}_{it-1})$. |
| $\text{Age}_{t-1}$ | $\ln(1+\text{age}_{it-1})$. |
| $\text{Sales}_{t-1}$ | $\text{total sales}_{it-1}/\text{total assets}_{it-1}$. |
| $\text{Cash flow}_{t-1}$ | $(\text{EBIT}_{it-1} - \text{interest payments}_{it-1} - \text{non-operating income}_{it-1} - \text{extraordinary items}_{it-1})/\text{total assets}_{it-1}$. |
| $\text{Market share}_{t-1}$ | share of firm's sales over the aggregated sales of the belonging industry (in $t-1$). |
| $\text{Vertical integration}_{t-1}$ | $\text{value added}_{it-1}/\text{total sales}_{it-1}$. |
| $\text{International network}_t$ | dummy identifying companies with stable and relevant, direct or indirect connections with foreign firms. |
| $\text{Domestic network}_t$ | dummy identifying companies with stable and relevant, direct or indirect connections with (only) domestic firms. |
| $\text{Network}_{t-1}$ | dummy identifying companies with stable and relevant, direct or indirect inter-firm connections (independently by the extension). |
| $\text{Group}_{t-1}$ | dummy identifying companies belonging to corporate groups (in $t-1$). |
| $\text{Human capital}_{t-1}$ | share of graduated employees in $t-1$. |
| $\text{Log-productivity}_t$ | $\ln(\text{value added}_{it}/\text{employees}_{it})$. |
| $\text{Log-sales}_t$ | $\ln(\text{sales}_{it})$. |

[a] GVC and NVC are defined in section 3.1.
[b] Arm-length, Hierarchy, Quasi-hierarchy, and Relational are defined in section 3.2.