

Global Value Chains, Governance, and Upgrading: Firm-Level Evidence from Italy

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ABSTRACT

This paper contributes to recent studies on international production and Global Value Chains (GVCs) by testing the effect of GVC participation on firms' upgrading capacity. We address this research question by focusing on the Italian experience and proposing a novel approach to identify GVCs and their forms of governance. Our findings support the existence of upgrading premia for globally-connected firms, 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 crucial role played by firm capacity in the generation, transfer, and diffusion of knowledge.

JEL classification: D24, F23, F26, O30.

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

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1 Introduction

The fragmentation of the production processes, the deep changes in distribution channels and transportation costs, and the diffusion of information technologies that characterized the last decades turned upside down the worldwide productive system. 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, Ishii, and Yi, 2001](#); [OECD, 2013](#); [Baldwin and Venables, 2013](#)). Within this evolving framework, firms were called for a radical reorganization of their activities that frequently translated into the creation or reinforcement of cross-boarder inter-firm connections. This issue has become even more crucial 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 international production and value chains literature by testing the effect of GVC participation on the upgrading capacity of a company. We go beyond standard approaches analyzing the link between internationalization and corporate performance, and ask whether firms' way to produce on a global scale affects knowledge exchange and learning opportunities; this, in turn, may heavily influence firm upgrading propensity. We address this research question by proposing a novel approach to identify GVCs and their forms of governance, and exploring heterogeneities along firms' performance, productivity, innovativeness, R&D, and export activity between 2008 and 2013.

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 furnishes 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.¹

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 suppliers, with high division of labor, and frequent

¹Indeed, [Giuliani, Pietrobelli, and Rabellotti \(2005\)](#) point out that relational GVCs —the most dynamic form of GVC and the governance that offers the ideal conditions for upgrading— are the least likely to occur within LDCs because of the lower average capability of suppliers.

inter-firm connections. While traditional studies on Italy emphasize the role of industrial clusters, districts, and of buyer-supplier spatial proximity, recent economic mutations require 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, Di Maria, and Micelli, 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.² In other words, the recent Italian experience offers a privileged point of view to explore the role of value chains and GVC governance in affecting firms' strategies and performance.

There are several features of the analysis that is 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 gain from international linkages. The richness of dataset is exploited to propose a novel empirical definition of value chains and GVC 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 participation in the conception of the final product. Our empirical approach improves upon the use of simplistic proxies and permits to analyze the effect of GVC participation over and above the role played by firms' degree of internationalization. The database also provides information on firm structural characteristics, behaviors, and strategies allowing to explore several dimensions of firm upgrading. Even if our conception of upgrading is more oriented toward strategic behaviors (ranging from a detailed breakdown by product, process, and organizational-managerial innovations, 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

²Notice that the timing of our sample does not allow for analyzing behavioral changes between pre- and post-crisis periods. We further discuss this issue in section 2.

and performance.³

The main findings of the paper are easily summarized. Despite 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’ probability of upgrading. 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 GVC, have a 4%-to-8% higher probability of innovating (especially for the introduction of new products) and undertaking R&D projects. *Vice versa*, arm-length, captive, and hierarchical relationships seem to have no significant role in fostering a firm’s innovativeness. Interestingly, belonging to GVCs also boosts the exporting probability of previously non-internationalized companies, albeit the impact is found to be more homogeneous across the different forms of governance.

These effects are not limited to firms’ probability of upgrading, but also extend to the magnitude of the upgrade undertaken (intensive margins) and to firm performance. These 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: international trade and performance, and the relationship between GVCs and upgrading strategies.

The first, and most known, strand of the literature explores the link between internationalization and

³Indeed, upgrading should be seen as a multidimensional measure of performance taking into account not only productivity gains but also product improvements as well as firm involvement in new functions and sectors (Humphrey and Schmitz, 2002b; Kaplinsky, 2004; Giuliani, Pietrobelli, and Rabellotti, 2005).

firm performance, analyzing the mechanisms 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 highly industrialized countries (Bernard and Jensen, 1999; Bernard and Wagner, 2001; Delgado, Farinas, and Ruano, 2002; Head and Ries, 2003; Girma, Greenaway, and Kneller, 2004; Castellani and Zanfei, 2007), Latin America (Clerides, Lach, and Tybout, 1998; Pavcnik, 2002), Asian countries (Aw, Chen, and Roberts, 2001; Hallward-Driemeier, Iarossi, and Sokoloff, 2002; Kraay, 2006), and least developed economies (Van Biesebroeck, 2005);⁴ their results are often mixed, leaving room for additional explorations on the direction of causality between export and productivity gains.⁵

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 furnishes 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, Dicken, Hess, Coe, and Yeung, 2002; Humphrey and Schmitz, 2002b; Sturgeon, Van Biesebroeck, and Gereffi, 2008; Navas-Alemán, 2011; Antràs and Chor, 2013; among others). The emphasis of these studies is on

⁴For a more comprehensive review see Wagner (2007).

⁵At the theoretical level, a number of papers (including Melitz, 2003; Bernard, Eaton, Jensen, and Kortum, 2003; Melitz, Helpman, and Yeaple, 2004; Yeaple, 2005; Ghironi and Melitz, 2005) take the results from the empirical literature to develop models of international trade with heterogeneous firms aiming at studying the linkage between productivity and export.

the opportunities for local producers to take advantage from new markets and to learn from global leaders along the chains. The common rationale is that complex and organized relationships produce positive effects that go beyond the mere sum of bilateral connections because of the exchange of managerial expertise and technical knowledge. In other words, GVCs are seen as a fertile environment for firms' upgrading: from the introduction of product and process innovation, to functional and inter-chain upgradings (Dolan and Humphrey, 2000; Humphrey and Schmitz, 2002b). In this regard, the nature of the relationships among the actors involved in the chain is seen to have crucial implications for development because of its influence on the generation, transfer, and diffusion of knowledge (Altenburg, 2006; Pietrobelli and Rabellotti, 2011). Thus, the mere participation in GVCs should not be considered as a synonymous for firm upgrading capacity, which instead depends upon firms' own way to relate with other enterprises.

The work of Gereffi, Humphrey, and Sturgeon (2005) identifies three key determinants of value chain governance patterns:⁶ (i) the complexity of information and knowledge transfer required for the transaction; (ii) the possibility to codify information and have efficient knowledge transmission without transaction-specific investments between the parties; 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* GVCs— each one characterized by different channels of knowledge transfer along the chain: from spillovers and imitation (marked-based relationships) to standards, codes, and technical definitions (modular GVCs), from the turnover of skilled workers (hierarchical) to direct knowledge transfers (captive) or mutual learning (relational GVCs).⁷

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, resulting into

⁶The notion of *governance* of the value chains is defined as the “authority and power relationships that determine how financial, material, and human resources are allocated and flow within a chain” (Gereffi, 1994).

⁷*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.

heterogeneous upgrading capacity across firms.⁸ In particular, relational GVCs are considered to offer the ideal conditions for upgrading (Humphrey and Schmitz, 2002b) because of the mutual learning from face-to-face interactions, and the high level of (complementary) competences required. The common rationale is that firms in GVCs need some skills not only to handle the knowledge they already have, but also to access external sources of knowledge (Cohen and Levinthal, 1989). Indeed, in order to reduce the risk of “residual incompatibilities” between the product design and the components manufactured (Puga and Trefler, 2010), multinational companies are more willing to transfer knowledge to skilled partners using it effectively within the GVC agreements (particularly when appropriability regimes are strictly defined, Gereffi, Humphrey, and Sturgeon, 2005). Moreover, capable firms are also more likely to be interested in participating knowledge-intensive relationships because of the higher payoff they expect to earn from accessing external sources of knowledge. In this regard, higher supplier capabilities also imply a certain degree of autonomy creating incentives to stimulate efficiency gains, accumulation of technical skills, and investments in creative activities.

The GVC literature is thus able to provide a different perspective to analyze the effects of internationalization on firm productivity and upgrading capacity: the critical issue is not only being internationalized, but *how* firms are inserted in the global production process. Differences in the forms of governance underlying buyer-supplier relationships strongly affect the knowledge transmission along the chains and are potentially able to explain heterogeneities in firms’ upgrading capacity.

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, Bamber, and Gereffi, 2011), from electronics (Sturgeon, 2002; Borrus, Ernst, Haggard, 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, Memedovic, Van Biesebroeck, and

⁸A collateral strand of the GVC literature specifically explores firm upgrading. Humphrey and Schmitz (2002b) 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, Pietrobelli, and Rabellotti, 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, Pietrobelli, and Rabellotti (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, Humphrey, and Sturgeon (2005) focus on the effect of technological change (and the evolution of specific production functions) on GVC governance.

Gereffi, 2009; Sturgeon and Van Biesebroeck, 2010)—, while only a few examples exploit plant-level data.

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, Giunta, and Rossi (2011) investigate the relationship between functional upgrading and firm performance between 2008 and 2009. Chiarvesio, Di Maria, and Micelli (2010) analyze the links among internationalization, innovation strategies, and performance of SMEs. Giovannetti, Marvasi, and Sanfilippo (2014) document a positive association between the probability of internationalization and firms' involvement in *filière* (on the 2011-wave of the MET survey). Finally, Giunta, Nifo, and Scalera (2012) focus on sales growth, while Agostino, Giunta, Nugent, Scalera, and Trivieri (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 of 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.⁹ Moreover, the dataset conveys even information on the behavior of micro-sized firms with less than 10 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 crisis.¹⁰

⁹Given the strong inter-sectoral connection highlighted by the literature on value chains, a sample that is representative of the overall economy (see section 4 for more details) is a necessary condition for a broad approach to GVCs.

¹⁰The 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 (Escalaith, Lindenberg, and Miroudot, 2010; see also Boehm, Flaaen, and Pandalai, 2014, for the role of trade and multinational firms in the

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 availability of data 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 literature, we exploit information on the stability of inter-firm relationships, the affiliation to corporate groups, and the degree of participation in the conception of the final product to classify companies into arm-length, hierarchical, captive, and relational suppliers.¹¹ This last form of governance will be the major focus of our paper since most of the existent literature —typically analyzing LDCs characterized by a low diffusion of the phenomenon— was not able to adequately test its role.¹² We then exploit this information to study several dimensions of upgrading based on both the extensive and intensive margins of innovation (further classified into product, process and organizational-managerial ones), R&D, and export activity, as well as productivity and sales growth.¹³

cross-country transmission of shocks). This is consistent with the findings of [Burstein, Kurz, and Tesar \(2008\)](#); [Bergin, Feenstra, and Hanson \(2009\)](#); [Ng \(2010\)](#); [Bergin, Feenstra, and Hanson \(2011\)](#); [Gangnes, Ma, and Van Assche \(2012\)](#), 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 on our results.

¹¹In the same spirit, [Saliola and Zanfei \(2009\)](#) propose an alternative classification based upon three different forms of GVC governance.

¹²Indeed, relational GVCs are the least likely to occur within least developed countries ([Humphrey and Schmitz, 2002b](#); [Giuliani, Pietrobelli, and Rabellotti, 2005](#)). Instead, our focus on the Italian economy, characterized by a higher share of capable companies, allows to empirically investigate the role of relational GVCs.

¹³Notice 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.

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 effect of GVC participation.¹⁴

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 Identifying global value chains

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 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:

¹⁴In other words, previous papers on GVCs —employing simple proxies based on firm degree of internationalization— may suffer from confoundedness of the results linked to potential learning-by-exporting effects.

		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. 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”).¹⁵ 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 considered to be part of a GVC (cells 2 and 6). Similarly, a company importing its inputs *and* exporting final goods is totally integrated in a global dimension 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 import input factors *or* export 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).

¹⁵A firm is said to be in a long value chain if participates in the production process of a GVC, but has no 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 is 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.

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 punctual information on the existence of “stable and relevant direct or indirect relationships with foreign companies”. We regard this as a necessary condition for the belonging to GVCs. By exploiting this additional dimension, we are able to identify partially-internationalized companies that participate in a GVC (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).^{16,17}

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.¹⁸ The excluded group is deemed to be composed by stand alone companies.

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

3.2 Identifying GVC forms of governance

Most of the theoretical literature suggests that the mere participation in GVCs is not sufficient to ensure firm success. We test this proposition by grouping companies along different forms of GVC governance and exploring heterogeneities in their upgrading propensities.

The criterion proposed by Gereffi, Humphrey, and Sturgeon (2005) requires knowledge on suppliers’ capability as well as on the complexity and codifiability of the transactions. Since this information is typically difficult to quantify, sector specific, and unavailable, we propose a similar classification based upon some indirect proxies. Our approach exploits data on the existence of stable and relevant commercial inter-firm relationships, the affiliation to corporate groups, and the degree of participation in the conception of the final product. Firms in GVCs are then further classified into arm-length, hierarchical, captive, and relational

¹⁶Notice that this classification is only feasible for manufacturing firms. Companies in the service sectors are defined to be in 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.

¹⁷Throughout 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).

¹⁸The MET survey also provides a question on the existence of “stable and relevant direct or indirect relationships with domestic companies”.

suppliers according to the following scheme:

1. *Arm-length suppliers*: companies without any stable and relevant commercial relationship with client firms.¹⁹ In this regard, the absence of strong ties with other companies in a GVC implies a low degree of dependence, and implicitly requires a high degree of codifiability of the transactions. This, in turn, proxies for the low switching costs highlighted by the literature.
2. *Hierarchical suppliers*: firms in a GVC that are subsidiaries of a corporate group (typically managerially controlled by a parent company which is often the leader of the chain).²⁰
3. *Captive suppliers*: companies with relevant and stable relationships with client firms, and no participation in the conception of the final product.²¹ The existence of relevant commercial networks proxies for their strong dependence, while the absence of participation in the definition of the final product captures the low capability of the supplier, as well as the potential high control/monitoring by the lead firm and client's specification.
4. *Relational suppliers*: firms characterized by relevant stable relationships with client firms, and high degree of participation in the definition of the final product. Also in this case, relevant commercial networks proxy for mutual dependence, while firms' participation in the conception of the final product captures the high capability of the supplier.²²

It is worth emphasizing that the availability of repeated interviews implies an identification of GVC participation that is time varying. In other words, our measures permit to capture changes in the GVC status as well as upgrading phenomena along the value chain.²³ This variation has crucial importance in the identification of the effects of interest, allowing for the inclusion of firm-specific fixed effects aimed at purging the

¹⁹This information comes directly from the following question in the MET survey: "are there any stable and significant relationships with other companies for commercial purposes?".

²⁰To 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).

²¹The existence of commercial network is defined as in Footnote 19, while firms' degree of participation 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, captive suppliers are required to have no participation (0), but we also try alternative thresholds (1 or 2) with no significant changes in the results.

²²Throughout the paper we impose a positive threshold for firms' participation in the conception of the final product. 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).

²³This characteristic is extremely important for the GVC literature, since the concept of governance is typically seen to be largely dynamic (Humphrey and Schmitz, 2002a).

estimates from firms’ unobservable heterogeneity.²⁴

3.3 Econometric specification

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 specifications test the existence of upgrading premia—in terms of extensive margins—for firms in global and national value chains (equation (1)), or analyze heterogeneities across the different forms of GVC governance (equation (2)):

$$Pr(Y_{it} = 1) = \phi(\alpha_1 GVC_{it-1} + \alpha_2 NVC_{it-1} + \beta_1^\top X_{it-1} + \lambda_{r,p,s}^\top + \lambda_t), \quad (1)$$

$$Pr(Y_{it} = 1) = \phi(\alpha^\top GOV_{it-1} + \beta_2^\top X_{it-1} + \lambda_{r,p,s}^\top + \lambda_t). \quad (2)$$

Y_{it} is the dichotomous dependent variable—either innovation, R&D, or export—, GVC_{it-1} and NVC_{it-1} are indicators for global and national value chains, while GOV_{it-1} is a vector of dummy variables identifying the beginning-of-period GVC forms of governance.²⁵ The standard reduced form equations (1) and (2) include 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.²⁶ The latter aims at purging the estimates from the mere effect of internationalization on firms’ upgrading capacity. Finally, λ_t and $\lambda_{r,p,s}$ are time effects and controls for firms’ industry (12), region (20), or geographical province (110) capturing common shocks that are time varying and permanent effects driven by the belonging sector or the geographical location of a company.²⁷

²⁴See section 3.3 below.

²⁵Notice 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.

²⁶A detailed definition of the variables employed is provided in Appendix.

²⁷Notice 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.

Because of the high persistence in the phenomena of interest, most of the analysis is performed through pooled probit models with heteroskedasticity-consistent standard errors. However, we also implement some panel data estimators allowing for the inclusion of firm-specific and time fixed effects.²⁸

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.²⁹

We address these econometric issues in several ways. 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 the dependent variable and the participation in GVCs are highly persistent.³⁰ To overcome this issue we estimate equations (1) and (2) also on the subset of non-upgrading firms in $t - 1$ (i.e. $Y_{i,t-1} = 0$),³¹ or, alternatively, allowing an AR(1) process for the regressand.³² Moreover, we also employ conditional logistic and linear probability models accounting for the inclusion of individual fixed effects that clean the estimation from all firms' (observable and unobservable) characteristics that are stable over time.³³ Notice that this approach permits to purge the possible self selection of permanently more dynamic firms into GVCs. Finally, we further take care of self selection by estimating our baseline specifications for a subsample of "balanced firms" recovered through Coarsened Exact Matching techniques (CEM, [Iacus, King, and Porro, 2011](#)).^{34,35}

²⁸Our choice of the econometric model is entirely driven by the research question we are dealing with. Although models that fully exploit the panel structure of the data have the great advantage to control for firm-specific idiosyncratic components, they require variation over time of the binary dependent variables. Given the high persistence and state-dependence of innovation, R&D, and export, these models produce an excessive reduction in the sample size, implying a selection bias due to the chosen empirical approach. However, we also present results from conditional logistic models in section 5.5.

²⁹Indeed, the existence of fixed sunk costs required to transmit product specifications, monitor and coordinate workers abroad ([Melitz, 2003](#); [Melitz, Helpman, and Yeaple, 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).

³⁰Indeed, innovation activity and R&D typically display strong persistence because of the cumulative nature of learning processes ([Rosenberg, 1976](#)), "success-breeds-success" ([Stoneman and David, 1986](#)), or strategies of innovation/R&D smoothing.

³¹Notice that, when dealing with firms' exporting status, this approach rules out all the endogeneity that is intrinsic in the definition of GVC. 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.

³²This robustness check (not reported) is still performed through pooled probit models. It is worth stressing that the introduction of lagged dependent variables in our analysis (on a pooled cross-section and without any control for firm fixed effects) does not produce any bias in the estimators requiring the use of dynamic panel data techniques.

³³As anticipated in Footnote 28, the price to pay for the inclusion of firm fixed effects is a relevant reduction in the sample size (-56% to -92%, depending on the specification).

³⁴In other words, we first employ a coarsened exact matching to identify a subsample of firms with the same *ex ante* probability of GVC participation (matched for age, size, region, industry, human capital, and productivity), and then exploit the new balanced sample to re-estimate equations (1) and (2).

³⁵Our choice to employ CEM rather than standard propensity-score matching techniques is driven by its appealing properties

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.³⁶ 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 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 specifications (1) and (2) (tobit models 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.³⁷ 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 participation 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.

in the estimation of causal effects (by reducing imbalance in covariates between treated and control groups): the monotonic imbalance bounding 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, Iacus, King, and Porro, 2009). However, we also test the robustness of our results to the use of standard matching techniques with qualitatively similar findings.

³⁶This is the case if the two financial crises induced differential effects across industries and regions. Notice that, while we control for industrial and regional heterogeneities that are constant over time (embedded in $\lambda_{r,p,s}$), the baseline specification does not account for time-varying correlated shocks.

³⁷Each 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 \(2012\)](#).

From the original dataset the application of selection-filters produces a relevant contraction in the sample size. The major reduction comes from the focus (for econometric purposes) on multiply-interviewed companies and firms with complete balance-sheet information.³⁸ 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 19,000 to 14,000 observations.

4.1 Descriptive statistics

Table 2 presents summary statistics for the main variables employed. Overall, 20% of the firms in the sample belongs to our definition of GVC (employing roughly 40% of the total labor force in Italy):³⁹ 29% are relational suppliers, while arm-length, captive, 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, R&D, and export. Firms belonging to GVCs display higher propensities of upgrading, with shares of dynamic companies that are two-to-four times larger than

³⁸This induces a sample reduction of about 60%.

³⁹As 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
Hierarchy	Dummy	0.025	0.157	0.000	1.000
Captive	Dummy	0.055	0.227	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	Dummy	0.189	0.391	0.000	1.000
Proc	Dummy	0.149	0.356	0.000	1.000
Org	Dummy	0.169	0.374	0.000	1.000
Share innovation (firm)	Bounded	0.032	0.135	0.000	1.000
Share innovation (market)	Bounded	0.045	0.172	0.000	1.000
Export share	Bounded	0.101	0.213	0.000	1.000
R&D share	Bounded	0.009	0.051	0.000	2.500
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: Descriptive statistics: industrial breakdown.

Industry	NVC	GVC	Arm-length	Hierarchy	Captive	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: diffusion of GVC and GVC governance by industrial sector. All measures are defined in Appendix.

non-GVC firms. This phenomenon is strongly heterogeneous across forms of governance and is mainly driven by the higher dynamism of relational suppliers.

The aim of the next section is to assess whether this evidence only represents a positive association, or

instead there is a causal nexus linking GVCs, supplier capability, and firms’ upgrading propensity.

Table 4: Conditional upgrading propensity by GVC form of governance.

	Innovation	R&D	Export
Non GVC	18.9%	9.67%	10.2%
GVC	41.1%	36.8%	67.8%
Arm-length	39.1%	14.9%	62.5%
Hierarchy	30.6%	26.6%	64.9%
Captive	31.4%	21.5%	64.5%
Relational	43.1%	39.8%	69.8%

Notes: percentage of innovative firms (column 1), R&D companies (column 2), and exporters (column 3) conditionally on their participation in GVCs and GVC forms of governance. All measures are defined in Appendix.

5 Results

This section presents the results of the paper. We first 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 the real impact on productivity and sales growth.

5.1 GVC participation and firms’ upgrading

Tables 5 presents results for the baseline specification (equation (1)) on the extensive margins of innovation. Firms belonging to GVCs display an innovative propensity that is 5%-to-8% 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).

In order to account for the possible reverse causality driven by persistence of firms’ innovativeness, columns 4–6 present the estimates for the subsample of non-innovative companies in $t - 1$ ($Y_{i,t-1} = 0$). Also in this case, GVC participation is found to significantly foster firms’ innovative propensity (4% increase for the richest specification in column 6).

The other controls present sensible coefficients too. In line with *a priori* expectations structural charac-

Table 5: GVC participation and firms' innovativeness.

Sample:	Y: Innovation					
	(1)	Entire (2)	(3)	Innovation _{t-1} = 0		
				(4)	(5)	(6)
GVC	0.080*** [0.009]	0.048*** [0.009]	0.048*** [0.009]	0.069*** [0.008]	0.044*** [0.008]	0.043*** [0.008]
NVC	0.013 [0.009]	0.008 [0.009]	0.008 [0.009]	0.010 [0.008]	0.005 [0.008]	0.005 [0.008]
Size	0.053*** [0.002]	0.032*** [0.002]	0.031*** [0.002]	0.022*** [0.002]	0.009*** [0.002]	0.009*** [0.002]
Age	-0.012** [0.005]	-0.007 [0.005]	-0.006 [0.005]	-0.007 [0.005]	-0.002 [0.004]	-0.002 [0.004]
Sales	-0.016*** [0.004]	-0.006 [0.004]	-0.006 [0.004]	-0.001 [0.004]	0.006 [0.004]	0.006 [0.004]
Cash flow	0.176*** [0.036]	0.142*** [0.034]	0.142*** [0.034]	0.113*** [0.033]	0.087*** [0.031]	0.083*** [0.031]
Market share	0.039 [0.046]	-0.081* [0.045]	-0.098** [0.046]	-0.163*** [0.048]	-0.221*** [0.047]	-0.244*** [0.047]
Vertical integration	-0.015 [0.012]	-0.001 [0.012]	-0.002 [0.011]	-0.019* [0.011]	-0.011 [0.010]	-0.008 [0.010]
R&D		0.262*** [0.006]	0.263*** [0.007]		0.181*** [0.006]	0.172*** [0.006]
Network		0.063*** [0.008]	0.062*** [0.008]		0.086*** [0.007]	0.088*** [0.007]
Group		0.051*** [0.008]	0.046*** [0.008]		0.014* [0.007]	0.012 [0.007]
Human capital			0.023 [0.017]			0.097*** [0.014]
Export			0.001*** [0.0001]			0.001** [0.0001]
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
# obs.	18887	18887	18797	14112	14112	14057
Pseudo-R ²	0.109	0.162	0.163	0.098	0.157	0.176
Loglik	-10372	-9756	-9692	-5362	-5010	-4886
LR $\chi^2()$	2543***	3775***	3764***	1168***	1872***	2094***

Notes: marginal effects from probit models. The dependent variable is *Innovation*. The left panel reports the estimates on the entire sample, while the right panel refers to subset of non-innovative firms in $t - 1$. All measures are defined in Appendix. *, **, *** denote, respectively, significance at 10%, 5%, and 1% level. Robust standard errors in brackets.

teristics play a critical role in affecting firm innovativeness, with large and young 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 skilled workers (human capital), and to international trade (learning-by-exporting and imitation). 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 than 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 the persistence of the dependent variable (not significant in column 6). 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).

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

Sample:	Y: R&D					
	(1)	Entire (2)	(3)	(4)	R&D _{t-1} = 0 (5)	(6)
GVC	0.076*** [0.007]	0.076*** [0.008]	0.074*** [0.008]	0.044*** [0.006]	0.044*** [0.006]	0.052*** [0.009]
NVC	0.025*** [0.008]	0.025*** [0.008]	0.023*** [0.008]	0.013** [0.006]	0.013** [0.006]	0.014 [0.009]
Size	0.054*** [0.002]	0.053*** [0.002]	0.052*** [0.002]	0.022*** [0.002]	0.021*** [0.002]	0.019*** [0.002]
Age	-0.011*** [0.004]	-0.012*** [0.004]	-0.010** [0.004]	-0.009*** [0.003]	-0.010*** [0.003]	-0.009** [0.003]
Sales	-0.027*** [0.004]	-0.026*** [0.004]	-0.023*** [0.004]	-0.013*** [0.003]	-0.012*** [0.003]	-0.011*** [0.003]
Cash flow	0.111*** [0.030]	0.118*** [0.030]	0.102*** [0.030]	0.067*** [0.025]	0.064** [0.025]	0.047* [0.025]
Market share	0.101*** [0.036]	0.101*** [0.037]	0.067* [0.037]	-0.044 [0.036]	-0.054 [0.036]	-0.079** [0.037]
Vertical integration	-0.030*** [0.010]	-0.040*** [0.010]	-0.026*** [0.010]	-0.020** [0.008]	-0.019** [0.008]	-0.011 [0.008]
Network		0.073*** [0.007]	0.069*** [0.007]		0.057*** [0.006]	0.058*** [0.006]
Group		0.012*** [0.007]	0.009 [0.006]		0.011* [0.006]	0.006 [0.006]
Human capital			0.210*** [0.013]			0.147*** [0.010]
Export			0.002*** [0.0001]			0.001*** [0.0001]
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
# obs.	18888	18888	18797	15966	15966	15663
Pseudo-R ²	0.216	0.235	0.265	0.144	0.145	0.182
Loglik	-7670	-7669	-4325	-4314	-4214	-4121
LR χ^2 ()	4235***	4238***	4242***	1455***	1458***	1522***

Notes: marginal effects from probit models. The dependent variable is *R&D*. The left panel reports the estimates on the entire sample, while the right panel refers to subset of firms with no R&D projects in $t - 1$. All measures are defined in Appendix. *, **, *** denote, respectively, significance at 10%, 5%, and 1% level. Robust standard errors in brackets.

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, relational GVCs are considered to offer the ideal conditions for upgrading because of the high level of competences required to handle the existent knowledge and access external sources.⁴⁰ 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 equation (2) on 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 chain governance. Coherently with theoretical predictions, suppliers involved in relational GVCs display a degree of innovativeness that is 3%-to-10% higher than non-GVC companies.⁴¹ These effects statistically dominate other forms of GVC governance (not significant in the richest specification of column 3), 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).⁴²

As an additional point, Table 8 investigates differential effects for the breakdown of product, process, and organizational-managerial innovations.⁴³ As expected, relational suppliers display the broadest range of innovativeness, albeit with a strictly decreasing intensity from product (5.7%), to process (2.3%), and organizational improvements (2.1%). Arm-length and hierarchical suppliers are characterized by a higher likelihood of introducing new production processes, while captive suppliers are more prone to adopt softer forms of innovations (i.e., organizational-managerial ones).⁴⁴

Table 9 presents the results for firms’ investment in R&D. Once again, the higher average degree of

⁴⁰On the other hand, unbalanced power relationships —such as captive or hierarchical GVCs— may inhibit upgrading and limit knowledge flows within the chain.

⁴¹We 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 the upgrading propensity of firms in GVCs, interpreting the estimated coefficients as deviations from stand alone companies and NVCs (our new benchmark).

⁴²These controls aim at purging the estimates from the possible self selection of more dynamic companies into knowledge-intensive forms of GVC governance.

⁴³Organizational-managerial innovations are defined as “the implementation of new organizational or managerial methods in the firms’ business practices, workplace organization or external relationships”. Even though they are clearly softer forms of innovation, this kind of improvements can be extremely relevant in economic context dominated by SMEs.

⁴⁴However, the effect on captive and hierarchical suppliers disappears once focusing on the subset of non-innovative firms in $t - 1$ (columns 4–6).

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

Sample:	Y: Innovation					
	Entire			Innovation _{t-1} = 0		
	(1)	(2)	(3)	(4)	(5)	(6)
Arm-length	0.041*** [0.014]	0.024* [0.014]	0.017 [0.014]	0.037*** [0.013]	0.028** [0.013]	0.023* [0.013]
Hierarchy	0.054*** [0.018]	0.007 [0.019]	0.003 [0.019]	0.040** [0.017]	0.027 [0.017]	0.026 [0.018]
Captive	0.049*** [0.017]	0.042** [0.017]	0.026 [0.017]	0.013 [0.015]	0.010 [0.016]	0.003 [0.016]
Relational	0.100*** [0.012]	0.056*** [0.013]	0.038*** [0.013]	0.074*** [0.011]	0.041*** [0.012]	0.033*** [0.012]
Size	0.058*** [0.002]	0.033*** [0.002]	0.031*** [0.002]	0.022*** [0.002]	0.010*** [0.002]	0.009*** [0.002]
Age	-0.012** [0.005]	-0.006 [0.005]	-0.006 [0.005]	-0.007 [0.005]	-0.002 [0.004]	-0.002 [0.004]
Sales	-0.016*** [0.004]	-0.006 [0.004]	-0.006 [0.004]	-0.001 [0.004]	0.006 [0.004]	0.006 [0.004]
Cash flow	0.195*** [0.036]	0.153*** [0.034]	0.143*** [0.034]	0.119*** [0.033]	0.089*** [0.031]	0.083*** [0.031]
Market share	0.085* [0.046]	-0.052 [0.045]	-0.095** [0.046]	-0.151*** [0.048]	-0.218*** [0.047]	-0.244*** [0.047]
Vertical integration	-0.027** [0.012]	-0.008 [0.012]	-0.002 [0.011]	-0.023** [0.011]	-0.013 [0.010]	-0.008 [0.010]
R&D		0.270*** [0.006]	0.263*** [0.007]		0.181*** [0.006]	0.172*** [0.006]
Network		0.066*** [0.008]	0.068*** [0.008]		0.088*** [0.007]	0.088*** [0.007]
Group		0.052*** [0.008]	0.046*** [0.008]		0.014* [0.007]	0.011 [0.007]
Human capital			0.023 [0.017]			0.097*** [0.014]
Export			0.001*** [0.0001]			0.001** [0.0001]
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
# obs.	18888	18888	18797	14112	14112	14057
Pseudo-R ²	0.095	0.151	0.162	0.097	0.157	0.177
Loglik	-10537	-9877	-9696	-5364	-5009	-4882
LR χ^2 ()	2214***	3533***	3756***	1163***	1874***	2103***

Notes: marginal effects from probit models. The dependent variable is *Innovation*. The left panel reports the estimates on the entire sample, while the right panel refers to subset of non-innovative firms in $t - 1$. All measures are defined in Appendix. *, **, *** denote, respectively, significance at 10%, 5%, and 1% level. Robust standard errors in brackets.

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 7%-to-13% higher than non-GVC companies, while the effects of other forms of governance are not statistically significant (in column 6).

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

Table 8: GVC forms of governance and firms' innovativeness: heterogeneities by innovation type.

Y: Form of innovation						
Sample:	Entire			Innovation $_{t-1} = 0$		
Form of innovation:	Prod (1)	Proc (2)	Org (3)	Prod (4)	Proc (5)	Org (6)
Arm-length	0.009 [0.011]	0.023** [0.011]	0.007 [0.012]	0.010 [0.010]	0.017* [0.009]	0.004 [0.010]
Hierarchy	0.019 [0.015]	0.028** [0.012]	-0.019 [0.015]	0.015 [0.012]	0.012 [0.010]	0.009 [0.013]
Captive	0.017 [0.014]	0.021* [0.013]	0.032** [0.015]	0.007 [0.012]	0.012 [0.011]	0.018 [0.012]
Relational	0.057*** [0.011]	0.023** [0.010]	0.021* [0.011]	0.051*** [0.009]	0.015* [0.008]	0.024** [0.009]
Size	0.012*** [0.002]	0.022*** [0.002]	0.030*** [0.002]	0.003* [0.002]	0.007*** [0.001]	0.011*** [0.002]
Age	-0.006 [0.004]	-0.002 [0.004]	-0.015*** [0.004]	-0.002 [0.003]	0.001 [0.003]	-0.006* [0.003]
Sales	-0.008** [0.004]	-0.004 [0.003]	0.002 [0.003]	0.001 [0.003]	0.002 [0.003]	0.006** [0.003]
Cash flow	0.091*** [0.029]	0.097*** [0.028]	0.089*** [0.029]	0.049** [0.025]	0.069*** [0.023]	0.055** [0.024]
Market share	-0.041 [0.036]	0.044 [0.033]	0.005 [0.037]	-0.132*** [0.033]	-0.045 [0.029]	-0.114*** [0.033]
Vertical integration	-0.012 [0.010]	0.008 [0.010]	0.007 [0.010]	-0.012 [0.008]	-0.002 [0.008]	-0.002 [0.008]
R&D	0.230*** [0.005]	0.150*** [0.005]	0.114*** [0.006]	0.141*** [0.004]	0.091*** [0.004]	0.072*** [0.005]
Network	0.028*** [0.007]	0.044*** [0.007]	0.051*** [0.007]	0.036*** [0.005]	0.055*** [0.005]	0.056*** [0.006]
Group	0.004 [0.007]	0.021*** [0.006]	0.039*** [0.007]	-0.015 [0.016]	0.011* [0.007]	0.015** [0.006]
Human capital	0.017 [0.014]	0.005 [0.013]	0.030** [0.014]	0.069*** [0.011]	0.045*** [0.010]	0.049*** [0.011]
Export	0.001*** [0.0001]	0.001*** [0.0001]	0.0001 [0.0001]	0.001*** [0.0001]	0.001*** [0.0001]	0.0001 [0.0001]
Controls						
Time	yes	yes	yes	yes	yes	yes
Industry(12)	yes	yes	yes	yes	yes	yes
Region(20)	yes	yes	yes	yes	yes	yes
Province (110)	yes	yes	yes	yes	yes	yes
# obs.	18797	18798	18798	15891	15962	16028
Pseudo-R ²	0.208	0.144	0.091	0.222	0.167	0.109
Loglik	-7260	-6924	-7883	-3908	-3612	-4224
LR $\chi^2()$	3817***	2347***	1590***	2235***	1452***	1036***

Notes: marginal effects from probit models. The dependent variables are product innovations (*Prod*) in columns 1 and 4, process innovations (*Proc*) in columns 2 and 5, or organizational-managerial innovations (*Org*) in columns 3 and 6. The left panel reports the estimates on the entire sample, while the right panel refers to subset of non-innovative firms in $t - 1$. 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 furnishes the opportunity to study whether the insertion in a global production process 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

Table 9: GVC forms of governance and firms' investment in R&D.

Sample:	Y: R&D					
	Entire			R&D _{t-1} = 0		
	(1)	(2)	(3)	(4)	(5)	(6)
Arm-length	0.045*** [0.011]	0.033*** [0.011]	0.018 [0.011]	0.021** [0.010]	0.010 [0.011]	0.006 [0.010]
Hierarchy	0.013 [0.014]	0.005 [0.015]	0.001 [0.014]	-0.011 [0.013]	-0.018 [0.014]	-0.018 [0.014]
Captive	0.027** [0.013]	0.052*** [0.014]	0.023* [0.014]	0.003 [0.012]	0.022* [0.013]	0.015 [0.013]
Relational	0.112*** [0.009]	0.139*** [0.010]	0.097*** [0.011]	0.073*** [0.008]	0.094*** [0.009]	0.078*** [0.009]
Size	0.062*** [0.002]	0.060*** [0.002]	0.051*** [0.002]	0.022*** [0.002]	0.021*** [0.002]	0.019*** [0.002]
Age	-0.012*** [0.004]	-0.012*** [0.004]	-0.011** [0.004]	-0.009*** [0.003]	-0.010*** [0.003]	-0.009** [0.003]
Sales	-0.028*** [0.004]	-0.026*** [0.004]	-0.023*** [0.004]	-0.013*** [0.003]	-0.012*** [0.003]	-0.011*** [0.003]
Cash flow	0.130*** [0.030]	0.128*** [0.030]	0.103*** [0.030]	0.067*** [0.025]	0.064** [0.025]	0.047* [0.025]
Market share	0.136*** [0.036]	0.121*** [0.037]	0.073** [0.037]	-0.044 [0.036]	-0.054 [0.036]	-0.079** [0.037]
Vertical integration	-0.042*** [0.010]	-0.040*** [0.010]	-0.026*** [0.010]	-0.020** [0.008]	-0.019** [0.008]	-0.011 [0.008]
Network		0.059*** [0.007]	0.063*** [0.007]		0.057*** [0.006]	0.058*** [0.006]
Group		0.019*** [0.007]	0.009 [0.006]		0.011* [0.006]	0.006 [0.006]
Human capital			0.210*** [0.013]			0.147*** [0.010]
Export			0.002*** [0.0001]			0.001*** [0.0001]
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
# obs.	18888	18888	18797	15966	15966	15663
Pseudo-R ²	0.202	0.204	0.242	0.135	0.138	0.173
Loglik	-7809	-7792	-7400	-4366	-4356	-4145
LR $\chi^2()$	3958***	3992***	4726***	1373***	1394***	1745***

Notes: marginal effects from probit models. The dependent variable is $R\&D$. The left panel reports the estimates on the entire sample, while the right panel refers to subset of firms with no R&D projects in $t - 1$. All measures are defined in Appendix. *, **, *** denote, respectively, significance at 10%, 5%, and 1% level. Robust standard errors in brackets.

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 10 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 60% higher than non-GVC companies, with an effect that is almost homogeneous

Table 10: Participation in long GVCs, forms of governance, and firms' exporting status.

Y: Export						
Sample:	Export _{t-1} = 0					
	(1)	(2)	(3)	(4)	(5)	(6)
GVC	0.637*** [0.007]	0.615*** [0.007]	0.609*** [0.007]			
Arm-length				0.338*** [0.018]	0.285*** [0.016]	0.233*** [0.016]
Hierarchy				0.107*** [0.032]	0.118*** [0.030]	0.109*** [0.032]
Captive				0.402*** [0.020]	0.544*** [0.019]	0.646*** [0.028]
Relational				0.450*** [0.015]	0.597*** [0.015]	0.600*** [0.018]
Size	0.023*** [0.002]	0.016*** [0.002]	0.015*** [0.002]	0.023*** [0.002]	0.013*** [0.002]	0.012*** [0.002]
Age	0.003 [0.004]	0.005 [0.004]	0.003 [0.004]	-0.001 [0.004]	0.001 [0.004]	0.001 [0.004]
Sales	-0.010*** [0.003]	-0.006 [0.003]	-0.006 [0.004]	-0.011*** [0.003]	-0.005 [0.003]	-0.005 [0.003]
Cash flow	0.118*** [0.028]	0.102*** [0.027]	0.092*** [0.027]	0.098*** [0.029]	0.083*** [0.027]	0.076*** [0.027]
Market share	0.111*** [0.043]	0.077** [0.041]	0.096** [0.044]	0.148*** [0.043]	0.105** [0.041]	0.111*** [0.042]
Vertical integration	-0.071*** [0.009]	-0.055*** [0.009]	-0.052*** [0.009]	-0.071*** [0.009]	-0.059*** [0.009]	-0.059*** [0.009]
R&D		0.113*** [0.006]	0.106*** [0.006]		0.096*** [0.006]	0.093*** [0.006]
Network		-0.211*** [0.007]	-0.160*** [0.007]		-0.159*** [0.007]	-0.160*** [0.007]
Group		0.015** [0.007]	0.014** [0.007]		0.015** [0.007]	0.014** [0.007]
Human capital			0.048*** [0.014]			0.048*** [0.014]
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
# obs.	16439	16439	16356	16439	16439	16356
Pseudo-R ²	0.514	0.528	0.535	0.503	0.555	0.562
Loglik	-5309	-5160	-5058	-5192	-4644	-4543
LR $\chi^2()$	11267***	11565***	11651***	10511***	11607***	11686***

Notes: marginal effects from probit models. The dependent variable is *Export*. Both the left and right panels report the estimates on the subset of non-exporter firms in $t - 1$. All measures are defined in Appendix. *, **, *** denote, respectively, significance at 10%, 5%, and 1% level. Robust standard errors in brackets.

across the different forms of governance. This evidence suggests that, even if the form of governance dramatically affects firms' upgrading strategy, the mere affiliation to GVCs may still produce significant effects in terms of market upgrading.

5.3 Intensive margins of innovation, R&D, and export

Previous findings clearly document the higher upgrading capacity 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 extensive margins.

To this purpose, we re-estimate equation (2) 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), 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). Similarly, we proxy R&D intensity with firms' expenditure in R&D projects (as a share of total sales), and export intensity as the share of sales from exported products.

Table 11 reports synthetic results from pooled tobit models. 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 significant impact for the other forms of GVCs (at least in column 6). Importantly, the effect is stronger for the introduction of truly innovative products (second panels) than for the implementation of pre-existent innovations (first panels). Their higher dynamic attitude is confirmed by the third panels presenting results for R&D intensity.

Finally, GVC participation also boosts the degree of international opening through strong and positive impact on firms' export activity. Once again, this effect is more homogeneous across forms of GVC governance and persists even for previously non-internationalized companies (belonging to long GVCs, columns 3–6).

5.4 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. The different nature of the dependent variables

Table 11: GVC forms of governance and firms' upgrading: intensive margins.

	Whole sample			$Y_{t-1} = 0$		
Y: Share innovation (firm)						
Arm-length	6.396*	0.338	0.186	15.36**	8.279	6.644
	[3.657]	[3.646]	[3.677]	[6.923]	[6.952]	[6.911]
Hierarchy	-0.464	-5.740	-5.899	-6.631	-1.304	-3.349
	[4.382]	[4.534]	[4.788]	[8.344]	[8.775]	[8.808]
Captive	9.726**	14.11***	9.404**	-4.072	8.155	2.410
	[4.394]	[4.574]	[4.533]	[8.671]	[8.985]	[9.074]
Relational	20.71***	18.74***	13.01***	31.36***	30.56***	23.99***
	[3.058]	[3.463]	[3.609]	[5.387]	[6.267]	[6.396]
Y: Share innovation (market)						
Arm-length	5.590	-1.066	-3.876	14.72	7.196	4.750
	[5.690]	[5.654]	[5.646]	[9.125]	[9.222]	[9.027]
Hierarchy	6.135	7.049	3.952	11.82	20.80*	18.63*
	[6.716]	[6.958]	[7.002]	[10.22]	[10.92]	[10.79]
Captive	8.332	11.52	6.142	2.042	10.00	1.870
	[6.983]	[7.218]	[7.250]	[11.07]	[11.70]	[11.57]
Relational	32.70***	23.74***	16.03***	47.89***	42.19***	28.75***
	[4.675]	[5.287]	[5.398]	[6.914]	[8.177]	[8.220]
Y: R&D share						
Arm-length	3.051***	2.133**	1.854*	4.322**	2.326	0.848
	[1.040]	[1.064]	[1.050]	[2.018]	[2.104]	[2.052]
Hierarchy	1.221	-0.003	0.355	-3.571	-4.920*	-5.223*
	[1.055]	[1.133]	[1.118]	[2.564]	[2.735]	[2.706]
Captive	2.057*	4.068***	4.174***	-0.327	3.410	0.578
	[1.246]	[1.338]	[1.318]	[2.376]	[2.564]	[2.533]
Relational	7.599***	9.742***	9.205***	8.030***	12.08***	7.639***
	[0.871]	[1.019]	[1.005]	[1.529]	[1.839]	[1.855]
Y: Export share						
Arm-length	21.34***	16.58***	16.46***	36.28***	25.69***	25.15***
	[1.166]	[1.153]	[1.155]	[2.313]	[2.274]	[2.278]
Hierarchy	5.437***	5.357***	5.662***	15.81***	17.96***	17.40***
	[1.485]	[1.570]	[1.579]	[3.445]	[3.532]	[3.542]
Captive	31.74***	41.13***	41.10***	47.23***	63.33***	62.93***
	[1.378]	[1.440]	[1.441]	[2.727]	[2.819]	[2.816]
Relational	35.40***	44.18***	43.93***	51.63***	68.76***	67.92***
	[1.042]	[1.170]	[1.171]	[2.067]	[2.285]	[2.284]
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

Notes: estimates from tobit regression models. The dependent variables are *Share innovation (firm)* in the top panels, *Share innovation (market)* in the second panels, *R&D share* in the third panels, and *Export share* in the last panels. Left panels report the estimates on the entire sample, while right panels refer to subset of firms for which $Y_{t-1} = 0$. All measures are defined in Appendix. Additional covariates in the estimations (not shown) varies across columns and follow the specifications in Table 7 for the two top panels, Table 9 for the third panels, and Table 10 for the last panels. *, **, *** denote, respectively, significance at 10%, 5%, and 1% level. Robust standard errors in brackets.

allows us to fully exploit the panel structure of the dataset and adopt a dynamic specification controlling for firm-specific and time fixed effects.

Table 12 reports the estimates from two-step system GMM models (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, allowing for a dynamic estimation of a small-T, large-N unbalanced panel, and taking into account heteroskedasticity and autocorrelation within

firms. Endogenous variables are instrumented with appropriately-lagged levels in the differenced equation and with their first differences in the level equation.

Table 12: GVC participation, forms of governance, productivity, and sales.

Y:	Log-productivity		Log-sales	
	(1)	(2)	(3)	(4)
GVC	0.0950* [0.0526]		0.0883*** [0.0276]	
Arm-length		-0.00606 [0.0590]		-0.0182 [0.0237]
Hierarchy		-0.0683 [0.0903]		-0.0398 [0.0377]
Captive		0.0520 [0.0513]		0.0423 [0.0300]
Relational		0.0957** [0.0484]		0.0495*** [0.0141]
$Y_{i,t-1}$	0.277*** [0.0432]	0.276*** [0.0429]	0.981*** [0.0289]	0.981*** [0.0286]
Age	0.167 [0.125]	0.0171 [0.0307]	0.00103 [0.00623]	-0.000406 [0.00627]
Size	-0.436 [0.373]	0.0410 [0.0784]	0.0493* [0.0277]	0.0505* [0.0273]
Export	0.371 [0.262]	0.0643 [0.0600]	-0.000741 [0.001340]	-0.000539 [0.00303]
Fixed effects				
Time	yes	yes	yes	yes
Firm	yes	yes	yes	yes
# obs.	7578	7578	17682	17682
Hansen p-value	0.217	0.344	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 over identifying restrictions. *AR(q) p-value* denotes the [Arellano and Bond \(1991\)](#) test of qth order serial correlation. *, **, *** denote, respectively, significance at 10%, 5%, and 1% level. Standard errors with [Windmeijer](#) finite-sample correction in brackets.

Even controlling for previous realizations of the dependent variables, for structural and strategic characteristics that are time varying, common shocks, and stable firm-specific factors, GVC participation is found to affect both productivity and sales growth.⁴⁵ This effect is stronger for firms' productivity (as defined by the log-value added per worker)⁴⁶ than total revenues, and is mainly confined to relational suppliers (characterized by 10%-higher productivity and a sales growth that is roughly 5% greater than other companies).⁴⁷

⁴⁵The Arellano-Bond test of second-order serial correlation of the error term indicates that values lagged twice or more are legitimate instruments for our endogenous variables. Moreover, the Hansen J-test does not detect any misspecification of the estimated model.

⁴⁶We also tried to perform the analysis on firms' TFP as an alternative measure for productivity. Results are mostly coherent, albeit not always significant.

⁴⁷Notice that, even if the dependent variable is in log-level, controlling for previous realizations of $Y_{i,t}$ allows to interpret the other estimates as partial effects on the growth rate.

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.

5.5 Robustness

We run a number of 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 equations (1) and (2). This approach provides consistent results and rules out any endogeneity issue driven by the persistence of innovation and R&D.⁴⁸
- We include regressors' mean to account for firms' unobserved heterogeneity in the pooled probit framework. This allows to purge the specification from the possible spurious correlation between GVC participation and some unobservable firm-specific factors that are stable over time. The inclusion of regressors' mean permits to control for most of the self selection and avoid the use of panel data techniques inducing relevant reductions in the sample size. Results are almost unaffected.
- We also exploit the panel structure of our dataset implementing conditional logistic regressions (on equations (1) and (2)) accounting for the inclusion of firm specific and time fixed effects. Even with a very reduced sample size, Table 13 presents results that are largely coherent with our previous findings, suggesting they are not driven by unobserved heterogeneity. We also implement linear probability models on the whole sample with unchanged results.
- 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, King, and Porro, 2011](#)) to select a subsample of firms with the same *ex ante* probability of belonging to GVCs (the treatment variable).⁴⁹ 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.

⁴⁸Because we are still dealing with a pooled cross section, and we do not control for any firm fixed effects inducing the so called [Nickell](#) bias, the inclusion of lagged dependent variables does not require the adoption of the same dynamic panel data techniques employed in Table 12.

⁴⁹Firms are matched along some structural characteristic, as well as human capital and productivity (see Footnote 34 for further details).

- 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 to account for third party factors affecting at the same time firms' innovativeness, R&D propensity, and export status. This approach accounts for the simultaneity of these 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 captive suppliers by choosing higher values of firm participation in the conception of the final product, or the (median and 75th percentile) share of graduated employees as alternative proxy for firm capability. In all cases results are largely unchanged.
- 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—, or province, as well as two-way clustering at the industry-region and firm-industry levels). Statistical significance of the estimates is roughly unchanged.⁵⁰
- Additional robustness checks are related to the enrichment of the matrix $X_{i,t-1}$ with: further lags for balance sheet measures (lagged twice or three times), alternative definitions of firms' size (log of total assets), alternative measures for R&D and export in Tables 7 and 8 (R&D share, share of employees devoted to R&D projects, and export share), 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.

⁵⁰Notice 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.

Table 13: GVC forms of governance and firms' upgrading: controlling for unobserved heterogeneity.

Y:	Innovation		R&D		Export	
	(1)	(2)	(3)	(4)	(5)	(6)
Arm-length	0.271 [0.256]	0.253 [0.272]	0.824** [0.334]	0.763** [0.337]	0.805 [0.535]	0.680 [0.556]
Hierarchy	0.332 [0.415]	0.372 [0.467]	-0.197 [0.476]	-0.468 [0.512]	1.565** [0.665]	1.689** [0.831]
Captive	0.382 [0.295]	0.301 [0.308]	-0.640* [0.378]	-0.583 [0.379]	2.508*** [0.671]	2.680*** [0.690]
Relational	0.646*** [0.224]	0.439* [0.241]	0.648** [0.277]	0.675** [0.279]	3.230*** [0.645]	3.322*** [0.675]
Size	0.181 [0.121]	0.0529 [0.129]	0.623*** [0.181]	0.591*** [0.183]	0.474* [0.281]	0.456 [0.296]
Age	0.780 [1.080]	0.813 [1.175]	-0.859 [1.384]	-0.972 [1.383]	-5.520** [2.592]	-5.302** [2.660]
Sales	0.260 [0.189]	0.413** [0.201]	-0.092 [0.257]	-0.068 [0.260]	-1.012* [0.527]	-1.010* [0.554]
Cash flow	-1.050 [0.970]	-1.266 [1.013]	-1.853 [1.521]	-1.847 [1.523]	-2.090 [2.948]	-1.913 [3.066]
Market share	-3.837 [4.129]	-4.346 [4.435]	3.225 [6.008]	3.073 [5.973]	8.664 [13.02]	7.224 [13.12]
Vertical integration	0.277 [0.486]	0.169 [0.495]	1.827** [0.788]	1.813** [0.777]	-0.977 [1.592]	-0.919 [1.641]
Network		0.563*** [0.127]		0.501*** [0.167]		0.0778 [0.589]
Group		0.191 [0.219]		0.279 [0.248]		0.400 [0.604]
Human capital		0.109 [0.399]		0.446 [0.430]		-2.135 [1.457]
R&D		1.488*** [0.173]				1.296* [0.668]
Fixed effects						
Time	yes	yes	yes	yes	yes	yes
Firm	yes	yes	yes	yes	yes	yes
# obs.	2507	2504	1595	1592	7949	7889
Loglik	-512	-464	-292	-290	-93	-89
LR $\chi^2()$	808***	901***	581***	582***	5618***	5582***

Notes: estimates from conditional logistic (panel) regression 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. All measures are defined in Appendix. *, **, *** denote, respectively, significance at 10%, 5%, and 1% level. Robust standard errors in brackets.

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 (such as their *ex ante* capability) affects 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 main GVC classes by 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 and forms of governance on firms' innovativeness, investment in R&D, export, performance, and productivity.

Our findings provide empirical support to the existence of upgrading premia for firms involved in GVCs (over and above the mere effect of internationalization), translating into a degree of innovativeness that is 4%-to-8% higher than stand-alone companies and enterprises in national value chains. These effects are very heterogeneous across forms of GVC governance, being mainly confined to highly-capable (relational) suppliers. We interpret this evidence as the crucial role played by firm 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.

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Appendix: variable definition

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

^aGVC and NVC are defined in section 3.1.

^bArm-length, Hierarchy, Captive, and Relational are defined in section 3.2.

Separate appendix: selected robustness checks

Table 14: GVC forms of governance and firms' upgrading: specifying Y as an AR(1) process.

Y:	Innovation (1)	R&D (2)	Export (3)
Y_{t-1}	1.243*** [0.0275]	1.534*** [0.0338]	1.374*** [0.0333]
Arm-length	0.0846 [0.0581]	0.110* [0.0667]	1.275*** [0.0926]
Hierarchy	0.00134 [0.0775]	-0.00461 [0.0854]	0.505*** [0.167]
Captive	0.0873 [0.0694]	0.0875 [0.0832]	1.697*** [0.111]
Relational	0.177*** [0.0517]	0.418*** [0.0646]	1.961*** [0.0891]
Controls			
Time	yes	yes	yes
Industry(12)	yes	yes	yes
Province (110)	yes	yes	yes
# obs.	12973	12946	13033
Pseudo-R ²	0.232	0.362	0.532
Loglik	-6309.9	-4489.7	-4217.4
LR χ^2 ()	3831.6***	5090.0***	9574.2***

Notes: estimates from probit models. The dependent variables are *Innovation* in column 1, *R&D* in column 2, and *Export* in column 3. All measures are defined in Appendix. Additional covariates in the estimations (not shown) follow the specifications in Table 7 (column 3) for the first column, Table 9 (column 3) for the second column, and Table 10 (column 3) for the the last column. *, **, *** denote, respectively, significance at 10%, 5%, and 1% level. Robust standard errors in brackets.

Table 15: GVC forms of governance and firms' upgrading: controlling for unobserved heterogeneity through regressors' mean.

Y:	Innovation (1)	R&D (2)	Export (3)
Arm-length	0.158 [0.0999]	0.266* [0.141]	0.802*** [0.115]
Hierarchy	0.128 [0.134]	0.118 [0.160]	0.815*** [0.245]
Captive	-0.0242 [0.116]	-0.0389 [0.159]	1.073*** [0.139]
Relational	0.162* [0.0853]	0.330*** [0.120]	1.532*** [0.119]
Controls			
Time	yes	yes	yes
Industry(12)	yes	yes	yes
Province (110)	yes	yes	yes
# obs.	18797	18797	18888
Pseudo-R ²	0.806	0.858	0.869
Loglik	-2237.3	-1382.4	-1698.2
LR $\chi^2()$	18675.0***	16763.2***	22521.7***

Notes: estimates from probit models. The dependent variables are *Innovation* in column 1, *R&D* in column 2, and *Export* in column 3. All measures are defined in Appendix. Additional covariates in the estimations (not shown) follow the specifications in Table 7 (column 3) for the first column, Table 9 (column 3) for the second column, and Table 10 (column 3) for the the last column. Regressors means (and the average of $Y_{i,t}$) are included as additional controls. *, **, *** denote, respectively, significance at 10%, 5%, and 1% level. Robust standard errors in brackets.

Table 16: GVC forms of governance and firms' upgrading: controlling for unobservable correlated shocks.

Y:	Innovation		R&D		Export	
	(1)	(2)	(3)	(4)	(5)	(6)
Arm-length	0.0634 [0.0492]	0.0615 [0.0500]	0.0853 [0.0528]	0.0914* [0.0537]	1.729*** [0.0867]	1.746*** [0.0884]
Hierarchy	-0.00840 [0.0658]	0.0153 [0.0667]	0.00344 [0.0679]	-0.00587 [0.0690]	0.485*** [0.153]	0.497*** [0.156]
Captive	0.101* [0.0609]	0.0897 [0.0618]	0.109* [0.0659]	0.107 [0.0669]	3.087*** [0.105]	3.127*** [0.108]
Relational	0.144*** [0.0486]	0.131*** [0.0493]	0.432*** [0.0509]	0.446*** [0.0519]	3.260*** [0.0856]	3.293*** [0.0871]
Controls						
Time×Industry (36)	yes	yes	yes	yes	yes	yes
Time×Region (60)	yes	no	yes	no	yes	no
Time×Province (330)	no	yes	no	yes	no	yes
# obs.	18798	18773	18798	18698	18798	18793
Pseudo-R ²	0.155	0.168	0.234	0.246	0.491	0.500
Loglik	-9772.9	-9627.0	-7473.9	-7346.4	-6554.1	-6444.4
LR $\chi^2()$	3604.7***	3878.2***	4580.7***	4787.4***	12682.3***	12895.9***

Notes: estimates from probit models. The dependent variables are *Innovation* in columns 1 and 2, *R&D* in column 3 and 4, and *Export* in column 5 and 6. All measures are defined in Appendix. Additional covariates in the estimations (not shown) follow the specifications in Table 7 (column 3) for columns 1 and 2, Table 9 (column 3) for columns 3 and 4, and Table 10 (column 3) for columns 5 and 6. *, **, *** denote, respectively, significance at 10%, 5%, and 1% level. Robust standard errors in brackets.

Table 17: GVC forms of governance and firms' upgrading: controlling for self selection through matching techniques.

Y:	Innovation		R&D		Export	
	(1)	(2)	(3)	(4)	(5)	(6)
GVC	0.303*** [0.0806]		0.177* [0.101]		3.385*** [0.154]	
Arm-length		0.0338 [0.124]		-0.110 [0.146]		0.943*** [0.191]
Hierarchy		0.455** [0.207]		0.361 [0.225]		1.231*** [0.222]
Captive		-0.115 [0.140]		-0.00227 [0.171]		1.741*** [0.235]
Relational		0.219** [0.102]		0.434*** [0.138]		2.331*** [0.219]
Controls						
Time	yes	yes	yes	yes	yes	yes
Industry(12)	yes	yes	yes	yes	yes	yes
Province (110)	yes	yes	yes	yes	yes	yes
# obs.	2075	2075	1989	1989	2030	1982
Pseudo-R ²	0.096	0.099	0.219	0.225	0.481	0.482
Loglik	-1238.5	-1235.9	-976.6	-969.1	-582.1	-684.8
LR $\chi^2()$	265.8***	271.1***	547.6***	562.6***	1529.3***	1278.5***

Notes: estimates from probit models. The dependent variables are *Innovation* in columns 1 and 2, *R&D* in column 3 and 4, and *Export* in column 5 and 6. Estimation is performed on a subsample of firms with balanced *ex ante* probabilities of belonging to GVCs (treatment variable). This selection results from the application of Coarsened Exact Matching techniques (CEM, [Iacus, King, and Porro, 2011](#)) on the following list of firm-level characteristics: age, size, region, industry, human capital, and productivity. Matching weights are then employed in the probit regression showed. All measures are defined in Appendix. Additional covariates in the estimations (not shown) follow the specifications in Table 7 (column 3) for columns 1 and 2, Table 9 (column 3) for columns 3 and 4, and Table 10 (column 3) for columns 5 and 6. *, **, *** denote, respectively, significance at 10%, 5%, and 1% level. Robust standard errors in brackets.

Table 18: GVC forms of governance and firms' upgrading: controlling for simultaneously third-party factors affecting innovation, R&D, and export.

Sample:	Entire			Innovation _{t-1} = 0 & R&D _{t-1} = 0		
	(1)	(2)	(3)	(4)	(5)	(6)
Innovation equation, Y: Innovation						
Arm-length	0.115** [0.046]	0.074 [0.048]	0.057 [0.048]	0.185*** [0.070]	0.172** [0.075]	0.162** [0.076]
Hierarchy	0.169*** [0.058]	0.045 [0.065]	0.011 [0.065]	0.220** [0.092]	0.156 [0.104]	0.143 [0.104]
Captive	0.130** [0.055]	0.113* [0.059]	0.088 [0.059]	0.053 [0.080]	0.080 [0.088]	0.067 [0.089]
Relational	0.291*** [0.041]	0.199*** [0.048]	0.149*** [0.048]	0.338*** [0.058]	0.184*** [0.070]	0.185*** [0.072]
R&D equation, Y: R&D						
Arm-length	0.199*** [0.049]	0.141*** [0.051]	0.019 [0.051]	.162** [0.079]	0.080 [0.083]	0.047 [0.084]
Hierarchy	0.068 [0.061]	0.049 [0.064]	-0.013 [0.066]	0.063 [0.099]	-0.050 [0.107]	-0.108 [0.109]
Captive	0.118** [0.060]	0.250*** [0.063]	0.037*** [0.064]	0.005 [0.093]	0.166* [0.101]	0.089 [0.102]
Relational	0.478*** [0.042]	0.674*** [0.047]	0.405*** [0.051]	0.566*** [0.061]	0.735*** [0.071]	0.608*** [0.075]
Export equation, Y: Export						
Arm-length	1.729*** [0.085]	1.736*** [0.085]	1.628*** [0.082]	1.976*** [0.107]	1.945*** [0.105]	1.929*** [0.105]
Hierarchy	0.421*** [0.144]	0.509*** [0.149]	0.438*** [0.143]	0.276 [0.176]	0.369** [0.180]	0.364** [0.180]
Captive	1.974*** [0.096]	3.041*** [0.102]	2.878*** [0.100]	2.031*** [0.116]	3.135*** [0.122]	3.133*** [0.122]
Relational	2.152*** [0.073]	3.199*** [0.083]	2.941*** [0.083]	2.270*** [0.091]	3.390*** [0.103]	3.343*** [0.104]
$\hat{\rho}_{21}$	0.453*** [0.012]	-0.029 [0.040]	-0.133*** [0.033]	0.534*** [0.015]	-0.011 [0.050]	0.066 [0.058]
$\hat{\rho}_{31}$	0.250*** [0.014]	0.177*** [0.015]	0.190*** [0.016]	0.234*** [0.018]	0.181*** [0.020]	0.171*** [0.021]
$\hat{\rho}_{32}$	0.308*** [0.015]	-0.017 [0.033]	-0.398*** [0.024]	0.238*** [0.019]	0.003 [0.036]	-0.108*** [0.039]
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
# obs.	18888	18888	18798	12978	12978	12933
Loglik	-24908	-24997	-24526	-13272	-12721	-12574
LR $\chi^2()$	8933***	10079***	12377***	4309***	5357***	5518***

Notes: estimates from multivariate probit models. The dependent variables are *Innovation* in the top panel, *R&D* in the second panel, and *Export* in the last panel. $\hat{\rho}_{ij}$ is the estimated correlation coefficient between the error terms of equations *i* and *j*. All measures are defined in Appendix. Additional covariates in the estimations (not shown) follow the specifications in Table 7 for the top panel, Table 9 for the second panel, and Table 10 for the last panel. *, **, *** denote, respectively, significance at 10%, 5%, and 1% level. Robust standard errors in brackets.