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Multichain strategies and economic upgrading in global value chains: Evidence from Kenyan horticulture

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ABSTRACT

An extensive body of research has examined the prospects for suppliers in the global South to upgrade within global value chains (GVCs) controlled by lead firms from, and oriented towards end-markets in, the global North. However, the expansion of South-South trade has altered the geography of GVCs. Previous studies highlight key differences between North-South value chains (NVCs) and South-South value chains (SVCs). Much less is known about the *multichain strategies* used by suppliers who participate simultaneously in NVCs *and* SVCs, and how these affect their prospects for economic upgrading. This article draws on the case of Kenyan horticultural suppliers to explore the implications of multichain strategies for economic upgrading, in terms of value-added tasks (product diversification and product sophistication) and economic returns (unit values). We adopt a mixed-methods approach combining transaction-level customs data for the 2006–2018 period with supplier interviews. We find that suppliers adopting multichain strategies experienced significantly more product diversification and higher economic returns than suppliers operating only in NVCs or SVCs, yet results for product sophistication are insignificant. Our results are robust to the use of multilevel linear regressions (MLRs), propensity score matching (PSM), and two-step system-GMM. The article highlights a critical need for GVC research to account for the multichain strategies of suppliers serving multiple and overlapping value chains, and their implications for economic upgrading.

1. Introduction

Despite widespread consensus that participation in global value chains (GVCs) can foster economic development in the global South (World Bank, 2019), there is compelling evidence to suggest participation alone is not sufficient (Barrientos et al., 2011; Fagerberg et al., 2018). Developing countries are often at risk of being 'locked' into segments of the value chain characterised by low value-adding potential and limited profits (Mudambi, 2008; Gereffi & Lee, 2012). The process of firms or countries extracting more value from participating in GVCs is explained in terms of economic upgrading (Humphrey & Schmitz, 2002; Pipkin & Fuentes, 2017). In horticulture GVCs, lead retailers concentrated in the global North have been observed to actively shape economic upgrading among their suppliers in the global South (Dolan & Humphrey, 2004; Maertens et al., 2012). They do so by governing the outsourcing of value-added tasks and the distribution of profits and risks through stringent and costly contractual arrangements, which significantly constrain suppliers' opportunities to participate and upgrade in GVCs (Alford, 2020; Nadvi, 2008; Ouma, 2010).

Recent changes in the geography of GVCs are, however, profoundly influencing these dynamics. In the last decade, total volumes of South-South trade have surpassed North-South trade, leading to an unprecedented expansion of South-South value chains (SVCs), where both lead firms and suppliers are located in the global South (UNCTAD, 2015; Mohanty et al., 2019). Significantly, this implies that Southern suppliers have potentially increased opportunities to serve multiple buyers across the global North and South (Horner & Nadvi, 2018). Such suppliers have been referred to as *multichain* (Navas-Alemán, 2011). Multichain suppliers devise different *multichain strategies*, ranging from decisions to vary product volumes sold across different markets, to shifting product types and standards in order to maximise earnings (Ponte & Ewert, 2009; Sako & Zylberberg, 2019).

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As opportunities to participate in SVCs emerge, horticulture suppliers can access new buyers and markets in the global South, thus hedging the risk of jettisoning perishable produce that fails to meet more stringent and costly Northern standards (Barrientos et al., 2016; Pickles et al., 2016). Suppliers can also take advantage of different crop seasonality across the North and South to offload or repurpose products, catering to different consumer preferences (Krishnan, 2018). While there are benefits, multichain strategies can also result in higher costs as suppliers need to comply with concurrent demands for multiple standards and production processes, which vary across Northern and Southern end-markets (Pasquali & Alford, 2021; Tessmann, 2018). Research has elucidated significant differences in economic upgrading of suppliers selling either to Northern or Southern buyers (Kaplinsky et al., 2011; Staritz et al., 2011; Pasquali, 2021a). Whilst these comparative studies are important, horticulture suppliers rarely operate in a single value chain (Pickles et al., 2016). As multichain strategies become increasingly dominant, we lack evidence of their impact on economic upgrading (Navas-Alemán, 2011; Horner & Nadvi, 2018). In this article, we tackle the question: *To what extent do multichain strategies affect suppliers' economic upgrading?*

We use a mixed-methods approach to analyse economic upgrading among first-tier suppliers in Kenya's horticulture industry. The case is particularly relevant, given Kenyan horticulture has long been dominated by a few European lead retailers (Barrett et al., 1999; Dolan & Humphrey, 2004). Yet, since 2010 trade in SVCs has grown significantly, leading to the expansion of multichain suppliers (Barrientos et al., 2016). Drawing on transaction-level export data for the period 2006–2018, we model the relationship between suppliers' multichain strategies and economic upgrading in terms of value-added tasks (i.e. product diversification and product sophistication) and economic returns (i.e. changes in unit values). We employ a combination of multilevel linear regressions (MLRs) and propensity score matching (PSM). Robustness is tested using two-step system-GMM and fixed-effect OLS. We further complement the quantitative analysis through in-depth interviews with 11 suppliers to shed further light on the link between suppliers' multichain strategies and economic upgrading.

Our results indicate that multichain suppliers experienced significantly more economic upgrading than their single-chain counterparts in terms of product diversification and, importantly, greater economic returns. Yet, we do not observe any significant difference in product sophistication. We also show critical limits to the benefits of employing multichain strategies, which depend on the different amounts of product sold across Northern and Southern markets. Based on these findings, our study underscores the analytical significance of multichain supplier firms, the strategies they employ to serve multiple and overlapping value chains, and the implications for economic upgrading.

The remainder of the article proceeds as follows. Section 2 explores the link between economic upgrading and multichain suppliers in GVCs. Section 3 discusses the rationale for case selection and describes the research methodology. Section 4 presents the empirical results. Section 5 concludes by discussing the study's significance and contributions to existing GVC and related literatures.

2. GVCs, upgrading and multichain strategies

2.1. Economic upgrading in GVCs: Situating multichain suppliers

Economic upgrading is a core focus of GVC research (Ponte et al., 2019). Gereffi's (1999, pp. 51–52) seminal definition refers to the 'ability of a firm or an economy to move to more profitable and/or technologically sophisticated capital and skill intensive niches'. Implicitly, this definition suggests that economic upgrading includes two aspects – the first is a value-added task, and the second is an improvement in economic returns/profits (Pipkin & Fuentes, 2017; Krishnan, 2018). Humphrey and Schmitz (2002) highlight the various forms of value-added tasks that a firm can perform, including: (i) the introduction of new and more sophisticated products (product upgrading); (ii) the implementation of new methods to transform inputs through superior technology and/or industrial organisation (process upgrading); (iii) the move into new production tasks in the same industry (functional upgrading); and (iv) into a new industry altogether (chain upgrading). In addition, economic upgrading also reflects changes in a firm's economic returns via 'increased profits deriving from a firm's participation in GVCs' (Gereffi & Lee, 2016, p. 29).

An analysis of economic upgrading therefore needs to consider both these critical aspects – the performance of value-added tasks and economic returns – in relation to a firm's participation in GVCs (De Marchi et al., 2018; Ponte, 2020). For instance, Krauss and Krishnan (2021) show that cocoa farmers in Nicaragua performed value-added tasks (process upgrading) by introducing internationally benchmarked standards; nevertheless, farmers simultaneously experienced lower profits and worsening soil conditions. Similarly, Ponte and Ewert's (2009) analysis of the South African wine industry suggests that, despite moving into lower value-added tasks, wine producers improved their economic returns. Critically, therefore, analysis of economic upgrading should include both components inherent in its definition – i.e. value-added tasks and economic returns.

Studies exploring the link between economic upgrading and firms' participation in GVCs have largely focused on how lead firms in the global North govern their interactions with suppliers in the global South (Humphrey & Schmitz, 2002; Blažek, 2016; Gereffi & Lee, 2016; Pipkin & Fuentes, 2017). The governance of sectors such as horticulture and light manufacturing is often referred to as 'buyer-driven', with large retailers in developed countries assuming the role of lead firms in governing products and knowledge flows (Gereffi, 1994). To participate in GVCs, suppliers in the global South must adhere to lead firms' governance structures, by complying with private standards, codes of conduct, and traceability requirements that determine product characteristics, production processes, as well as labour and environmental conditions (Nadvi, 2008; Ouma, 2010). Critically, it has been argued that governance by lead firms in the global North facilitates the consolidation of stable and long term networks, which enhances absorptive capacity among Southern suppliers (Ernst & Kim, 2002); increases their ability to comply with complex requirements (Riisgaard, 2009); and ultimately strengthens their prospects for economic upgrading (Gereffi, 1999, 2014).

Recent shifts in the geography of global trade are nevertheless impacting the governance of GVCs, with potential implications for the upgrading trajectories of Southern suppliers (Horner, 2016). Since 2009, countries in the global South – including least-developed, developing and transitioning economies – have been trading more with each other than with countries in the global North – broadly defined as comprising early-industrialised economies (UNCTAD, 2015, 2018; Horner & Nadvi, 2018). Between 2001 and 2019, the share of Southern countries' exports to other Southern countries increased from 39% to 57% of the global South's total export share; with the South-South percentage of total global trade increasing from approximately 14% in 2001 to 29% in 2021.[2]

[2] Statistics updated by authors based on WTO-ITC Trademap (2020) [https://www.trademap.org]. The definition of global North and South is based on UNCTAD (2018).

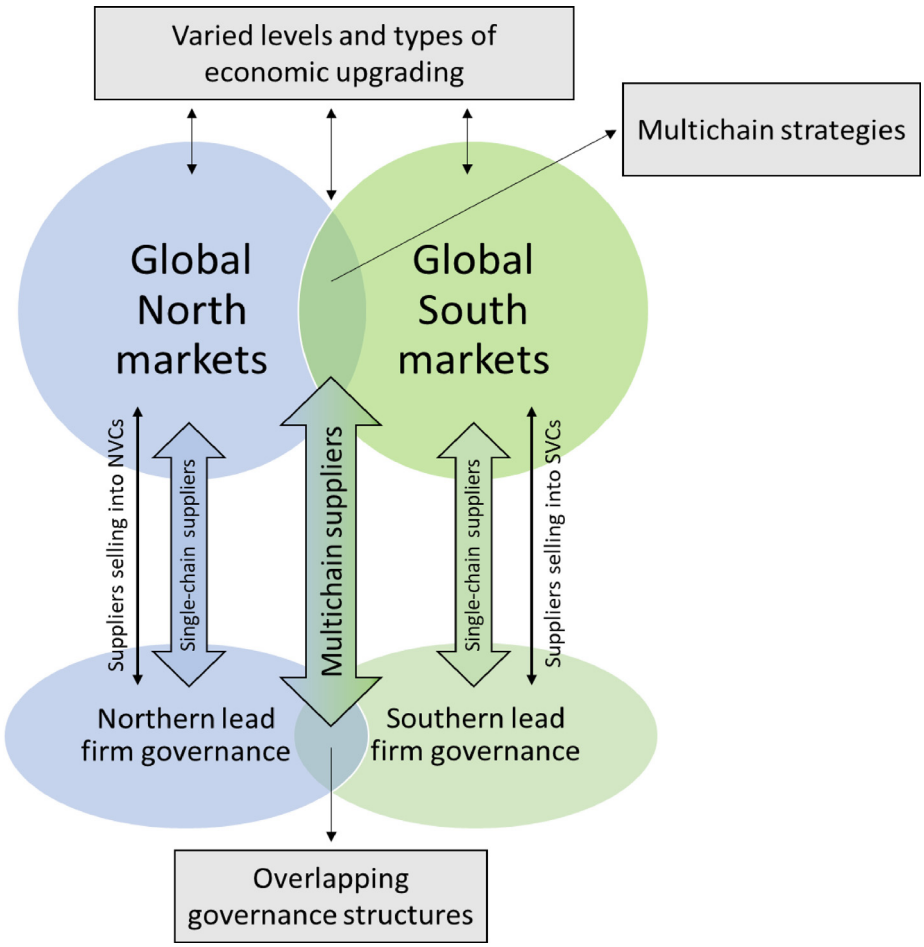

Fig. 1. Economic upgrading and multichain suppliers Source: authors' compilation.

Scholars have begun to question the implications of this new geography of trade for suppliers' economic upgrading (Horner & Nadvi, 2018; Pasquali, 2021a; 2021b; Yang, 2014). Emerging evidence indicates that relative to North-South value chains (henceforth referred to as NVCs), participation in SVCs can increase opportunities for economic upgrading through two pathways. First, it is argued that less demanding product and process standards in SVCs vis-à-vis NVCs reduces entry barriers by lowering compliance costs, hence facilitating suppliers' access to SVCs (Sheldon, 2012; Pickles et al., 2016). Second, the lower technology gap between Southern countries implies that Southern suppliers find it comparatively easier to upgrade in SVCs compared to NVCs (Amighini & Sanfilippo, 2014). Drawing on this, Franssen (2019) found that East African suppliers operating in SVCs capture a higher value share and face lower entry barriers than suppliers engaging with NVCs. Similarly, Barrientos et al. (2016) show that Kenyan and South African horticultural suppliers who shifted to serve Southern markets managed to introduce new processing methods, accompanied by better revenues.

Evidence relating participation in SVCs to higher prospects for economic upgrading is not undisputed. Studies have also found that the governance of SVCs is mostly based on spot-market interactions, thereby providing fewer opportunities for learning and knowledge sharing (Bazan & Navas-Alemán, 2004; Fessehaie & Morris, 2013). For example, Tessmann's (2018) analysis of the Ivorian cashew value chain found that relative to NVCs, SVCs are characterised by more sporadic and uncoordinated exchanges between buyers and suppliers, often mediated by third-party intermediaries, limiting suppliers' scope for economic upgrading. Similarly, Kaplisnky et al. (2011), found that Gabon timber suppliers transitioning from NVCs to SVCs experienced economic downgrading,[3] including both the export of lower value-added products and a reduction in prices.

Participation in NVCs and SVCs is, however, not mutually exclusive. As SVCs expand, 'producers increasingly weigh up a variety of different export market opportunities' which allows them to 'juggle multiple chains' across both the global North and the global South (Horner & Nadvi, 2018, pp. 227–228). Firms simultaneously involved in NVCs and SVCs are known as multichain suppliers (Navas-Alemán, 2011) (Fig. 1). Multichain suppliers adhere to different governance structures with varying requirements across NVCs and SVCs. Previous studies have examined firms' motivations to engage in multichain strategies, including minimising risk associated with overreliance on one market (Ivarsson & Alvstam, 2011), acquiring new skills and capabilities (Bazan & Navas-Alemán, 2004), and selling residual products discarded from NVCs (Krishnan, 2018). Nevertheless, the literature remains largely silent on the effects of suppliers' multichain strategies on economic upgrading, which 'requires looking at the need of firms to negotiate their participation in and opportunities across different end-markets' (Horner & Nadvi, 2018, p. 231). We address this gap by exploring whether multichain strategies provide suppliers with

[3] In this case, economic downgrading implies a process where suppliers shift to lower value-added tasks and reduce their economic returns from participation in GVCs. In this article, although we focus on upgrading, potential downgrading trends are also considered.

increased opportunities for economic upgrading vis-à-vis their counterparts serving only NVCs or SVCs.

2.2. Multichain strategies in horticulture value chains

An extensive literature has examined asymmetric power relations underpinning the governance of NVCs (Alford, 2020; Bair & Palpacuer, 2015; Dallas, Ponte, & Sturgeon, 2019), particularly in horticulture where economic rents are disproportionately captured by Northern retailers and suppliers' opportunities for economic upgrading are limited (Gibbon, 2001; Fold & Larsen, 2011; Krauss & Krishnan, 2021). However, recent studies indicate that suppliers in the global South can leverage different strategies to navigate lead firms' private governance demands and increase their ability to economically upgrade (Sako & Zylberberg, 2019). For instance, Choksy et al. (2017, p. 382) argue that disadvantaged suppliers in developing countries can achieve economic upgrading by 'actively designing and implementing strategies to capture higher profits in GVCs'.

One such strategy includes firms' cost-capabilities, referring to the ways firms internally coordinate to optimize resources and returns to capital. This can occur either through in-firm efforts to invest in technological capabilities via R&D activities and personnel training (Lall, 1992; Whitfield & Staritz, 2019), or by developing strategic linkages with private and public actors (including lead firms, universities, and training institutions), to foster innovation transfer and increase a firm's ability to compete in GVCs (Andersson et al., 2016; Perri et al., 2017). Significantly, research on firms' technological capabilities and innovation systems is extensive and overwhelmingly concentrated on manufacturing sectors in NVCs (Morrison et al., 2008; Pietrobelli & Rabellotti, 2011; De Marchi et al., 2018; Lema et al., 2018; Whitfield et al., 2020).

A second, and far less-studied, strategy available to Southern suppliers is to engage in *multichain strategies* across NVCs and SVCs. As Sako and Zylberberg (2019, p. 12) explain: 'capabilities are necessary but alone insufficient [to upgrade]. Suppliers must make decisions about whether they will remain captive to a single buyer or codify their products and services to diversify their buyer portfolio'. Especially in agro-food sectors, suppliers have been observed to 'position' themselves to take advantage of new markets (Neilson et al., 2018). This has been particularly the case in horticulture value chains because of their specific characteristics, including standards' variation across end-markets, the seasonality and perishability of produce, and the influence of soil and climatic conditions.

For example, following the expansion of supermarket chains across Eastern and Southern Africa, local green bean suppliers have been shown to 'strategically' sell sub-standard produce that fails to meet EU standards into SVCs, thus avoiding the cost of dumping perishable goods and hedging single-market risks (Barrientos et al., 2016). Similarly, Kenyan avocado suppliers with a long tradition of participating in NVCs have leveraged compliance with stringent Northern standards to market themselves as 'good quality producers' within SVCs (Krishnan, 2018). In South Africa's apple and citrus sectors, conducive soil conditions that facilitate year-round production and reversed seasonality vis-à-vis the Northern hemisphere, has enabled producers to differentiate away from traditional European clients towards emerging East Asian and African markets (Mogala, 2015; Boon, 2017).

Multichain strategies appear to be becoming an increasingly viable option for suppliers in the global South, but to date there has been limited systematic analysis of their impact on economic upgrading, particularly in agro-food sectors. Ground-breaking research on Brazil furniture and footwear sectors has shown that multichain suppliers can benefit from gaining new skills and capabilities applicable across NVCs and SVCs, thereby maximising opportunities for economic upgrading (Navas-Alemán, 2011). Similarly, a study of Eswatini's (former Swaziland) apparel manufacturing shows that between 2006 and 2014, suppliers that originally exported to the US shifted approximately half of their sales to South African lead firms, leading to product upgrading and improved economic returns, as they learned to cater for a wider range of buyers with different product and compliance standards (Pasquali et al., 2020).

Whilst an important contribution to the literature, these studies contain key limitations which we aim to address. First, they rely on cross-section survey data for a small sample of firms, restricting their ability to study the effects of firms' multichain strategies on upgrading over an extended time frame. Second, by utilising a fixed definition of 'multichain suppliers' (e.g. Navas-Alemán, 2011), they cannot account for the differential effect of incremental multichain strategies, as suppliers export different product quantities across NVCs and SVCs over time. Finally, they do not focus on horticulture value chains that, as we discussed above, present significantly different characteristics from manufacturing. In the following sections, we build on this literature and provide a first systematic attempt to evaluate the impact of multichain strategies on suppliers' economic upgrading in Kenyan horticulture.

3. Case context, research design and methods

We explore our research question drawing on evidence from Kenya's horticultural export sector, including fruits and vegetables.[4] First, Kenya has a long-standing involvement in NVCs as a supplier to European supermarkets (Barrett et al., 1999). This has been largely due to the colonial legacy and the early introduction of export variety crops such as green beans, snow peas and new varieties of avocados (Jaffee & Masakure, 2005; Krishnan, 2018). Kenya has therefore enjoyed a first mover advantage in East Africa allowing European supermarkets to reduce costs through the development of flexible, contractual food supply networks (Barrett et al., 1999; Dolan & Humphrey, 2004).

Second, the sector has seen considerable geographic diversification following the recent expansion of SVCs (Pickles et al., 2016). Over the 2006–18 period, horticulture exports to the global South increased more than fivefold reaching about 38% of the sector's total export share. Comparatively, exports to the global North have increased only slightly, with the 3-year moving average over the period 2006–2018 displaying a 16% growth - significantly below the 330% increase experienced by exports to the South (Fig. 2). Third, fruits and vegetables represent one of Kenyan's foremost foreign exchange earners, contributing 26% of its agricultural GDP, employing 5.5 million farmers and workers, and accounting for 8% of the country's total exports as of 2017 (Kangai & Gwademba, 2017).

3.1. Research design: A mixed-methods approach

We adopt a sequential two-stage approach primarily driven by quantitative data analysis. Qualitative interviews are further used as a 'supplemental component' to help interpret and explain the outcome of the econometric models (Ivankova et al., 2006; Schoonenboom & Johnson, 2017).

First, we develop indicators of economic upgrading and multichain strategies by utilizing a census of Kenyan customs export data for the period January 2006 to December 2018. This data is

[4] Floriculture, which is normally regarded as part of horticulture, is excluded. This is because Kenyan flower exports have and remain largely organised within NVCs, with Europe and the UK accounting for 86% of the country's total exports in 2018. A full list of products included in the analysis is presented in Table 9 (appendix).

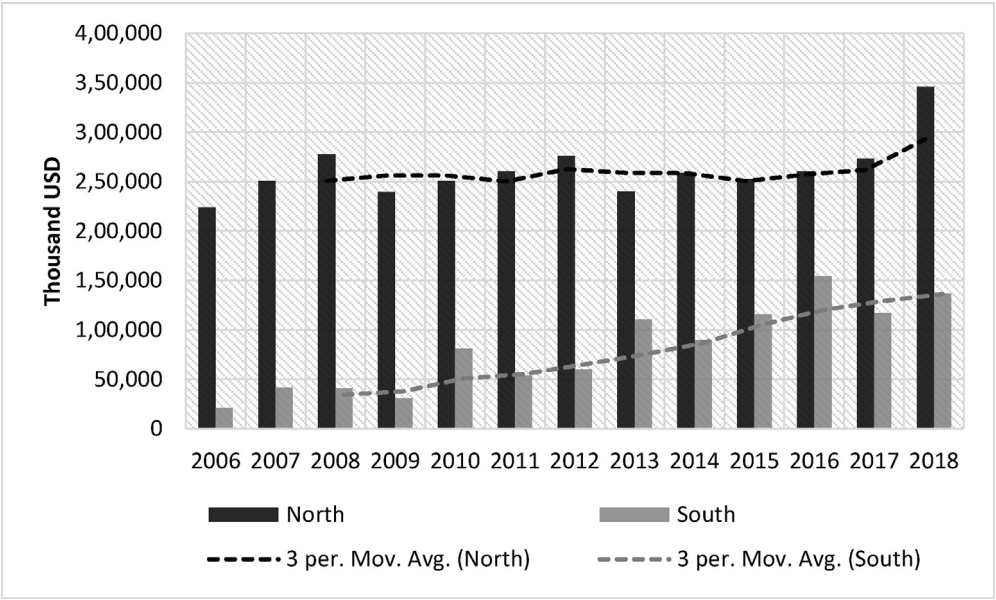

Fig. 2. Kenya's horticulture exports to the global North and South (thousand USD) Source: authors' compilation based on ITC (2020), fruits and vegetables, HS-07 and −08.

compiled by the Kenya Revenue Authority (KRA), which records export transactions, including information on consignor, consignee, quantity of exported produce, number of exported logs, transaction value, country of destination, and other specifics on export firms. Each transaction is linked to the World Customs Organization's Harmonized System (HS) 4- and 6-digit code identifying the traded product. Unlike aggregated trade data, transaction level data adds granularity and captures the heterogeneity of value chain linkages across firms within countries and sectors (World Bank, 2019).

At the same time, such dataset presents two important limitations. First, by focusing on formal exporting companies only, it underestimates the relevance of regional trade within the East African Community, which often occurs via informal and unrecorded channels (Gor, 2012). Second, the dataset provides no information on standard compliance across NVCs and SVCs or public governance (e.g. when laws or domestic standards were introduced or adopted), hence constraining our ability to quantitatively infer the impact of standards and regulations on upgrading. To partially address these limitations and nuance the implications of multichain strategies on upgrading, we supplement the analysis by means of qualitative interviews with selected multichain suppliers.

In the following subsections, we first define the econometric models and variables adopted, we then provide further information on the qualitative interviews.

3.2. Quantitative analysis: Variables and models

3.2.1. Dependent variables: Economic upgrading

We build on research which examines economic upgrading in terms of product sophistication and product diversification as indicators of value-added tasks linked to product and process upgrading. We further interrogate unit values as an indicator of firms' economic returns. In this way, we account for both components of economic upgrading – i.e. value-added tasks and economic returns.

Product diversification: We measure product diversification using the unweighted number of HS 6-digit level products exported by each firm at year *t* (Lubatkin et al., 1993; Kim et al., 2004; Liu, 2007). Unweighted product-count measures are reliable and have low information requirements (Lubatkin, et al., 1993; Van Oijen & Hendrikse, 2003). An increase in 'related product diversification' across products within the same sector has been associated with increased business performance and firms' competitive advantage, both aspects linked to economic upgrading (Hitt et al., 1997; Chang & Wang, 2007; Brancati et al., 2017).

Product sophistication: We use Hausmann product groups (HPG) which provide a widely accepted ranking of goods by technological intensity of products (Hausmann et al., 2007). HPG are constructed based on the HS 6-digit classification scheme, attributing a score from 1 to 5 to each good based on its incremental level of income content. However, primary horticulture products have a relatively lower degree of technological intensity, as they all fall within the first two HPG.[5] We therefore create a dummy variable, 0 if the exported good is unprocessed (low level of sophistication); and 1 if the good is processed (higher level of sophistication). The product sophistication variable is created by calculating the average HPG for each supplier at year *t*. A firm's increase in product sophistication underscores product upgrading (Van Assche & Van Biesebroeck, 2018). Table 7 (appendix) reports a list of all 4-digit HS product groups contained in the dataset, their exported value over the 2006–18 period, and their respective HPG.

Unit prices: To evaluate firms' economic returns, we look at changes in unit values. Changes in unit values have been used as an indicators of economic up- and downgrading in a number of GVCs studies (e.g. Curran & Nadvi, 2015; Van Assche & Van Biesebroeck, 2018; Pasquali, 2021a; Taglioni & Winkler, 2016). Significantly, it is argued that within the same country and product (and therefore net of localised price shocks), overtime variations in export unit values have been observed to reflect a firm's changes in revenue (Raikes & Gibbon, 2000; Manova & Zhang, 2012). Unit values are calculated by dividing the transaction's real value in USD by the quantity exported (Hallak, 2006; Fiankor et al., 2020). To account for inflation and depreciation, we use single deflation

[5] More sophisticated horticultural products are either frozen, dried, or canned for preservation. Whilst, theoretically, most products can undertake such processing, about 85% of processed horticultural products that Kenya exports is constituted by frozen green beans and peas, and canned green beans and pineapples.

using output-price deflators (Kathuria et al., 2013). We then calculate log average unit values for each exporter at year *t*.

3.2.2. Independent variable: Multichain supplier strategies

Suppliers at year *t* can either (i) sell into NVCs, if the end-market is in the global North; (ii) sell into SVCs, if the firm end-market is in the global South; or (iii) operate as multichain, if the firm exports to both the global North and South. Multichain suppliers can strategically alter export portfolios by changing the amount of product sold across NVCs and SVCs. We explore the variation in multichain strategies through three *thresholds*. We begin with a 10% threshold, i.e. firms that export at least 10% of their yearly exported value to NVCs and SVCs simultaneously. To explore different multichain strategies, we create two further variables identifying firms that have exported at least 20% and 30% of their yearly exported value across both NVCs and SVCs respectively.[6] By doing so, we can understand whether different multichain strategies carry differential implications for suppliers' upgrading.

3.2.3. Control variables

A set of control variables are used to capture dynamics that are likely to influence economic upgrading across multichain and single-chain suppliers. The most important are *governance* variables. As discussed in section 2, multichain suppliers adhere to different governance regimes across NVCs and SVCs, and thus it is critical to control for these different structures. Governance has been quantified by focusing on the buyer–supplier linkage in terms of knowledge and information transfer. This includes the stability of suppliers' relationships with their buyers, lead firms' technical support in production and sale, and the size of a firm's buyers/suppliers' network (e.g. Gulati, 1995; Glückler, 2005; Brancati et al., 2017). Drawing on these studies, we developed three indicators of governance: network stability, network size, and presence of intermediaries.

Network stability: In GVCs, firms do not act in isolation but 'within networks of relations that vary in their stability' requiring adherence to various requirements (Morris et al., 2016, p. 1249). Stable linkages between suppliers and lead firms are critical to knowledge transfer, accounting for socio-cultural differences such as language barriers, as well as enhancing technical and productive capabilities (Dallas, 2015). Using data from 198 biopharmaceutical firms headquartered in the United States between 1985 and 2005, Kumar and Zaheer (2019) develop an indicator of network stability in the interactions between lead-firms and suppliers. Following Kumar and Zaheer (2019), we operationalise network stability as the share of an exporting firm's ties with buyers that remain the same from year *t-1* to year *t*.

Intermediaries: GVC research shows that in horticulture, vertically integrated sourcing is adopted by buyers to reduce lead times and increase control over standardised production processes, hence favouring knowledge transfer and upgrading (Dolan & Humphrey, 2004; Dannenberg & Nduru, 2013). Conversely, in the absence of specific standard requirements, it becomes 'uneconomic/impractical' for buyers to link directly with suppliers (Gibbon, 2001, p. 351-352). In these cases, value chains tend to operate through third-party intermediaries. To identify the presence of intermediaries, first, we conducted a manual check of buyers to identify their status as lead firms or intermediaries (e.g. wholesale agents, importing agents). Subsequently, we calculated the likelihood that a firm's exports at year *t* take place through *direct sourcing* (no intermediaries present). A score closer to one indicates a higher likelihood that the firm interacts directly with its buyers at year *t*.

Network size: A broader export network enables suppliers to access a wider range of relevant knowledge outside their local boundaries (Gassmann & Keupp, 2007; Andersson et al., 2016). Previous studies have shown that a larger network size increases a firms' potential for upgrading (Glückler & Panitz, 2016; Corredoira & McDermott, 2020). We capture differences in suppliers' network size using the firm's total number of buyers at year *t* (Anand & Khanna, 2000).

Beyond governance variables, we also control for:

EPZ: Firms move to an Export Processing Zone (EPZ) to access preferential treatment on the importation of intermediate products for exports. EPZ firms tend to specialise in processing activities that are likely to correlate with higher product sophistication (Farole, 2011). We use a dummy variable equal to 1 if a firm was located in the EPZ at year t.

Export volume: The more a firm exports, the higher likelihood it will be able to trigger an efficient reallocation of resources and increased ability to upgrade (Almeida et al., 2003; Gebreeyesus & Mohnen, 2013). Moreover, larger exporters are in a superior position to withstand the higher entry costs characterising North-South value chains (Graner & Isaksson, 2009). We operationalise the firm's export volume using its yearly average of exported pallets (as sub-units of a container).[7]

3.2.4. Econometric models and estimation strategies

We adopt a linear growth model using multilevel linear regressions (MLRs) to allow for nested levels of analysis that account for both intra- and inter-firm variation. Bell et al. (2019) show that contrary to OLS modelling with fixed effects, MLRs account for inter-firm variation both in the starting year (intercepts) and over-time (slopes). In our case, if the variation between firms' upgrading and the average yearly upgrading across all firms is significantly different from 0, not accounting for time random slopes would result in a violation of the independence assumption, yielding biased and anticonservative standard errors (Schielzeth & Forstmeier, 2009; Bell et al., 2019). To compare the goodness of fit of the MLR vs OLS model, we further ran a set of likelihood ratio (LR) tests comparing the models with and without time random slopes. Estimates produced by the LR tests are all significant, suggesting that we should lean towards a model with both random intercepts and random slopes.

Our reduced form equation is as follows:

$$Y_{ijt} = \beta_0 + \beta_1 Time_t + \beta_2 \overrightarrow{Multi}_j + \theta\left(Time_t * \overrightarrow{Multi}_j\right) + \beta_3 \overrightarrow{x}_{ijt,t-1} + \mu_{0i} + \mu_{1i} Time_t + \epsilon_{ijt} \quad (1)$$

Time is a linear time trend. *Multi* is a vector of dummy variables indicating the status *j* of a supplier as selling into NVCs, SVCs, or being multichain at time *t*. The interaction between the *Time* trend and the *Multi* variables indicates the upgrading trend of NVCs and SVCs suppliers compared to multichain ones. A negative and significant coefficient in the interaction term (Θ) would suggest that upgrading in NVCs and SVCs suppliers is comparatively less pronounced than in multichain firms. To control for persistent differences between observables, uninteracted *Multi* variables are also included. As the *Time* trend variable is normalised to be 0 in the first year, the coefficients of the uninteracted *Multi* variables are interpreted as the percentage difference between multichain and NVCs/SVCs suppliers in the first year, 2006. *X* is a vector of control variables specified in section 4.1 for firm *i*, its status *j*, at time *t* and *t-1*.

[6] We do not consider a 40% threshold due to the lack of firms under this category.

[7] The dataset lacks information on firm size in terms of turnover or total number of employees. Furthermore, we do not use the firm's yearly exported value or quantity to avoid collinearity with the dependent variable.

The two terms μ_{0i} and μ_{1i} represent the random effects capturing the variation between each firm regression model and the average intercept across all firms (μ_{0i}), as well as the variation between each firm yearly change in ln*(UV)* and the average yearly change in ln*(UV)* (μ_{1i}) across all firms. In other words, μ_{0i} and μ_{1i} capture the firm-variance around the intercept and the yearly firm-variance around the slope respectively – where the random intercept is defined by $\beta_0+\mu_{0i}$ and the random slope by $(\beta_1+\mu_{1i})Time_t$. The variation between individual observations and the regression model within each firm is captured in the error term. Since exports by the same firm are likely to be endogenous and correlated with their respective error term, standard errors (SEs) are clustered by firm. Eq. (1) is estimated in its base form – i.e. without controls, (indicated in Tables 2 to 4 as MLR) and with controls (indicated in Tables 2 to 4 as MLR +).

For robustness, we estimate Eq. (1) using OLS with firm and time fixed effects. We also employ a two-step system-GMM estimator (Blundell and Bond, 1998; Roodman, 2009), which has been commonly used within GVC analysis (e.g. Giuliani et al., 2017). To deal with endogeneity (reverse causality and omitted variable bias), the two-step system GMM estimator uses lagged values of endogenous variables as instruments - including the dependent variable, as well as the governance indicators. Following Roodman (2009), the study checks for instrument proliferation by reducing the number of instruments, generating one instrument per variable. Thus *system-GMM effectively controls for endogeneity, while the MLR accounts for firm random slopes over time*.[8] Therefore, consistent results across both methods lend robustness.

The outcome of Eq. (1) may reflect a problem of *self-selection* as firms with particular characteristics (including unit values, sophistication, more stable and broader networks, export volume etc.) are more likely to be multichain and experience economic upgrading. To further ensure robustness of results, propensity score matching and difference-in-difference methods are used to control for potential self-selection (e.g. Baldwin & Yan, 2014; Maertens & Swinnen, 2009).

At the beginning of a period (*t-1*), a firm is either multichain or single-chain. At the end of a period (t), it has either maintained or changed its status.

$$Prob(E_{f,t} = 1) = \phi(\alpha_t + Z_{f,t-1}) \tag{2}$$

The probability of being a multichain firm ($E_{f,t}$) at time t is modelled as a function of a vector Z of firm-specific attributes ($Z_{f,t-1}$) at time *t-1* and time fixed effects (α_t). Where $Z_{f,t-1}$, includes all dependent variables (product sophistication, product diversification, and unit values), as well as the other control variables that directly impact economic upgrading (network stability, network size, intermediaries, EPZ, and export volume).

After the conditional probability of changing multichain status is estimated from Eq. (2), a propensity score is calculated for each firm. Firms that were multichain at year t are matched with firms that had the closest propensity score and that were not multichain. Balancing tests are conducted to ensure the quality of matching, using a number of different techniques (i.e. gaussian kernel, as well as nearest-neighbour method with and without replacement).

With the two samples created by the counterfactual, treated and control firms are followed over time. Firm f 's upgrading can be written as:

$$Y_{f,t} = \alpha_t^1 + \alpha_t^2 E_{f,t} + \alpha_t^3 Z_{f,t-1} + \alpha_f^4 + \epsilon_{f,t} \tag{3}$$

Where Y is firm f average unit values, product sophistication, and product diversification at time t. $E_{f,t}$ is a dummy variable capturing the status of firm f at year t. $Z_{f,t-1}$ is a set of prior firm-specific attributes at *t-1* defined in Eq. (2). The parameters α_f and α_t capture respectively year-specific and time-invariant unobserved firm-specific effects.

Propensity-score matching controls for selection bias by restricting the comparison to differences between treated and control firms with similar observable characteristics. This method is still susceptible to non-random selection bias due to unobservable characteristics that are associated with the treated group. Differencing Eq. (3) reduces the potential selection bias that arises from unobserved time-invariant firm-specific effects (Baldwin & Yan, 2014). Furthermore, to the extent that we are interested in *upgrading* as a dynamic increase of the dependent variable over time (rather than on its absolute value at year t), differencing Eq. (3) allows us to assess whether the status of a firm as *multichain* leads to a significantly larger increase in the dependent variable compared to single-chain firms. Eq. (3), in accumulated growth form, can be written as follows:

$$\Delta Y_{f,t} = \beta^1 + \beta^2 E_{f,t} + \beta^3 Z_{f,t-1} + \mu_f \tag{4}$$

Eq. (4) controls for year-specific (β^1) effects. The coefficient of interest is β^2, which represents the upgrading differential between the treated firms (multichain) and the matched control firms with similar attributes that were not multichain. In the first iteration (labelled as PSM in Table 6), E is coded as 1 for firms that are multichain at year t and as 0 firms that are not multichain at year t. In the second iteration (labelled as PSM + in Table 6), we compare only firms that stayed single-chain between *t-1* and t (coded as 0) with firms that either became multichain or stayed multichain (coded as 1). Finally, in the third iteration (labelled as PSM++ in Table 6), we set E equal to 1 if the firm became multichain, and 0 if the firm retained its status as single-chain. A positive and significant coefficient for β^2 across the three iterations would provide strong evidence that being a multichain firms leads to economic upgrading.

3.3. Qualitative supplier interviews

Our research design follows a sequential two-stage approach driven by quantitative data analysis, with qualitative interviews used to help interpret and explain the outcome of the econometric models (Ivankova et al., 2006). Qualitative interviews were conducted after the quantitative analysis to provide further depth on how multichain strategies had affected suppliers' experiences of economic upgrading. For this aspect of the research, we conducted semi-structured interviews with 11 multichain suppliers. The firms were selected from an official list of exporters provided by KRA for 2018 and triangulated with our dataset to uniquely identify firms that were multichain suppliers.[9] Eight multichain suppliers were selected among the 20 largest exporters (in terms of exported value) for the year 2018. In addition, three small suppliers, defined as having less than 50 employees, were also purposively selected. We acknowledge a bias towards large first-tier suppliers. Yet, these firms together account for about 40% of the sector exports, and therefore we believe that their responses are particularly insightful to explore the results of the quantitative analysis which covers the universe of Kenya's horticultural exporters.

[8] Despite our attempt to minimise the risk of endogeneity across the independent and dependent variables, we acknowledge that such risk still persists across the MLR and system-GMM models (especially in relation to the governance variables).

[9] Firms that exported more than 10% of their yearly exported value across NVCs and SVCs were classified as multichain.

Table 1
Characteristics of multichain and single-chain suppliers, 2006 to 2018.

		Multichain suppliers (10%) vs.		Multichain suppliers (20%) vs.		Multichain suppliers (30%) vs.	
		NVCs	SVCs	NVCs	SVCs	NVCs	SVCs
Dependent variables	Product diversification	−0.535***	−0.672***	−0.514***	−0.662***	−0.527***	−0.683***
		(0.078)	(0.079)	(0.083)	(0.087)	(0.106)	(0.111)
	Product sophistication	0.001	0.001	0.016	0.013	0.014	0.010
		(0.014)	(0.017)	(0.015)	(0.016)	(0.017)	(0.017)
	Unit values	0.182***	−0.757***	0.218***	−0.711***	0.244***	−0.675***
		(0.053)	(0.065)	(0.056)	(0.067)	(0.071)	(0.080)
Control variables	Network stability	0.035***	0.013	0.045***	0.024*	0.056***	0.036**
		(0.012)	(0.013)	(0.013)	(0.014)	(0.014)	(0.015)
	Intermediaries	0.153***	0.045	0.148***	0.030	0.133***	0.025
		(0.034)	(0.035)	(0.037)	(0.037)	(0.043)	(0.039)
	Network size	−0.904***	−1.249***	−0.812***	−1.181***	−0.757***	−1.136***
		(0.094)	(0.095)	(0.094)	(0.098)	(0.106)	(0.111)
	Export volume	−1.413***	−2.245***	−1.092***	−1.974***	−1.000***	−1.885***
		(0.218)	(0.225)	(0.233)	(0.246)	(0.267)	(0.282)
	EPZ	−0.015	−0.027***	−0.022	−0.034**	−0.027	−0.039**
		(0.010)	(0.009)	(0.016)	(0.015)	(0.019)	(0.019)

Notes: NVCs indicates single-chain suppliers selling to northern buyers. SVCs indicates single-chain suppliers selling to southern buyers. P-values (***, **, * indicate significance at 1%, 5% and 10% levels respectively). All regressions include year fixed effects. Standard errors (SEs) clustered by firm.

Interviews were conducted by the authors between August and October 2019 with managers at the respective firms.[10] During the interviews, respondents were presented with the outcome of the quantitative analysis and asked to discuss the impact of their multichain strategy on economic upgrading. The discussion was structured around the three dependent variables used in the quantitative analysis to define economic upgrading – i.e. product diversification, product sophistication, and unit values. Respondents were asked to relate their multichain strategy to each of these variables. Responses were fully anonymised and organised by themes using a grounded theory approach. Table 8 (appendix) provides further information on the interviewed firms, including size, location, products, markets, standards adopted, and processing carried out. Table 9 (appendix) classifies the main themes that emerged from the coding process.

4. Results: Supplier strategies and upgrading trajectories

4.1. Descriptive analysis: Multichain suppliers versus single-chain suppliers

Between 2006 and 2018, we observe a total 799,995 transactions carried out by 1,972 Kenya-based suppliers interacting with a total of 6,822 Northern and Southern buyers. The Kenyan horticulture market is relatively skewed in favour of large suppliers, with the top-10 exporters accounting for 43% of all transactions and 45% of the total export value. The percentage of multichain suppliers with a 10% multichain strategy increased from 8.6% in 2006, peaking at 11.7% in 2017 to 10.4% in 2018. Moving the threshold for multichain strategies to 20% and 30%, shows a more stable trend with the share of firms ranging from 3% to 7.9% at the 20% threshold and from 1.4% to 5.2% at the 30% threshold (Table 10, appendix). Whilst accounting for a relatively small share of suppliers, multichain firms reflect a larger share of exported value, ranging between 8.1% and 21.5% at the 10% threshold, between 3.3% and 13% at the 20% threshold, and between 0.2% and 10% at the 30% threshold (Table 11, appendix).

Our data further shows that in 2018, 61% of multichain suppliers were originally operating in NVCs, while only 17% transitioned from serving only SVCs to becoming multichain.[11] Across all three thresholds, single-chain NVCs suppliers have sold most of their produce to the EU and the US, whilst SVCs single-chain suppliers have traded mostly with buyers from the UAE, India, China, and other African countries (for a detailed country breakdown, see Table 12, appendix).

Multichain and single-chain firms differ in several key respects. The mean differences obtained by running OLS regressions on pooled cross-section data over the 2006–2018 period with year fixed effects, are reported in Table 1. Multichain firms have, on average, lower unit values than suppliers selling into NVCs and higher unit values than suppliers serving SVCs only. Furthermore, multichain suppliers export a significantly larger number of products compared to both NVCs and SVCs suppliers. However, the difference in product sophistication is insignificant. Table 13 (appendix) reports the mean and standard deviation of all dependent and control variables for NVCs, SVCs, and multichain firms.

Concerning governance variables, multichain firms supplied a significantly larger and less stable network of buyers and had an increased likelihood of operating via intermediaries than suppliers selling into NVCs. However, firms operating in SVCs presented similar degrees of network stability and intermediation as multichain suppliers. Multichain suppliers also exported significantly larger volumes of produce than both NVCs and SVCs single-chain suppliers. All coefficients remain consistent across the 10%, 20%, and 30% thresholds. Overall, apart from product sophistication, the results in Table 1 highlight significant differences between multichain and single-chain suppliers.

Figs. 3, 4, and 5 report the linear upgrading trends for single-chain suppliers to NVCs, SVCs, and multichain suppliers at the 10%, 20%, and 30% strategic thresholds. For product diversification (Fig. 3), the trend is marginally upward for multichain and NVCs suppliers across all thresholds, whilst single-chain SVCs suppliers presented a clear downgrading trend. For product sophistication (Fig. 4), the trend for multichain suppliers is positive across all thresholds and lower than the one observed among single-chain NVCs suppliers. In terms of unit values (Fig. 5), the results highlight an increasing trend for multichain suppliers. This is more pronounced than the one observed among NVCs and SVCs single-chain suppliers across all three thresholds. Interestingly, while

[10] Interviews were conducted in English by at least two researchers and subsequently transcribed. All interviews were carried out in person at the firm's premises.

[11] The percentage does not add to 100%, since 22% of multichain firms either started as such or became multichain before 2006.

the trend of multichain suppliers at 10% is similar to the 20% threshold, there are differences that emerge when considering the 30% threshold, with the steepness of multichain firms' trends decreasing across all indicators. A potential explanation is that this trend reflects firm-specific factors (other than multichain strategies) which are exacerbated by the small amount of multichain suppliers above the 30% threshold (see Table 10, final column).

4.2. Econometric and qualitative results

For each dependent variable, we present 3 variants of the MLR model from Eq. (1). Column 1 is the base model estimated by OLS. Column 2 shows the base model estimated with MLR with firm and time random slopes. In column 3 (MLR +), we further introduce control variables at time *t* and *t-1*.

4.2.1. Value-added tasks: Product diversification

Across all the model variants at 10% threshold, the *SVCs*Time* coefficients indicate that multichain suppliers diversified their products more than SVCs suppliers. In the MLR + iteration, results also hold their significancy across the 20% and 30% thresholds. The *NVCs*Time* coefficient, which compares multichain suppliers with suppliers serving only NVCs, despite maintaining a negative sign, is statistically insignificant across all thresholds (Table 2). This suggests that *multichain strategies relate to a significant increase in product diversification vis-à-vis SVCs suppliers*, but not necessarily compared to suppliers serving NVCs only.

The variables of network size and stability have a significant and positive effect on the number of products exported by Kenyan suppliers. Of 11 interviewed firms, four large and two small suppliers reported that stable interactions are critical in encouraging product diversification. This is because over time, the formation of consolidated buyer–supplier networks allows suppliers to gauge and justify the costs of diversifying into new products, as buyers' demand is likely to vary between seasons and years. A larger network of clients also allows suppliers to engage with a more diversified product range. As the product manager of S-5 explained:

> 'With our South African clients, we developed a great relationship. With time, they learnt to trust us and appreciate our produce. During South Africa's low season, we now sell them avocados, garlic, and ginger, as well as products that we would

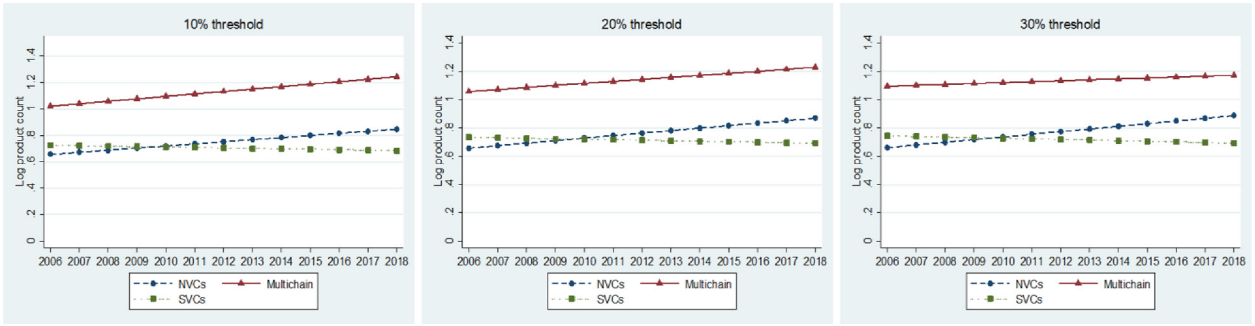

Fig. 3. Product diversification, linear trends for multichain and single-chain suppliers (10%, 20%, 30% thresholds).

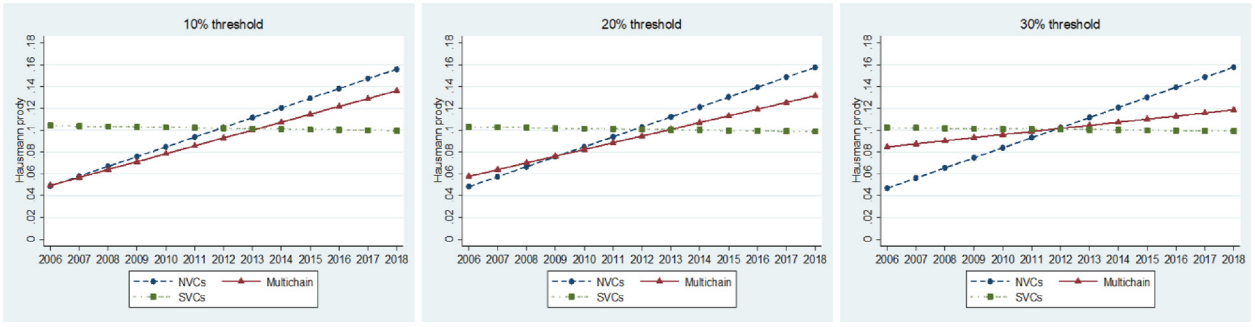

Fig. 4. Product sophistication, linear trends for multichain and single-chain suppliers (10%, 20%, 30% thresholds).

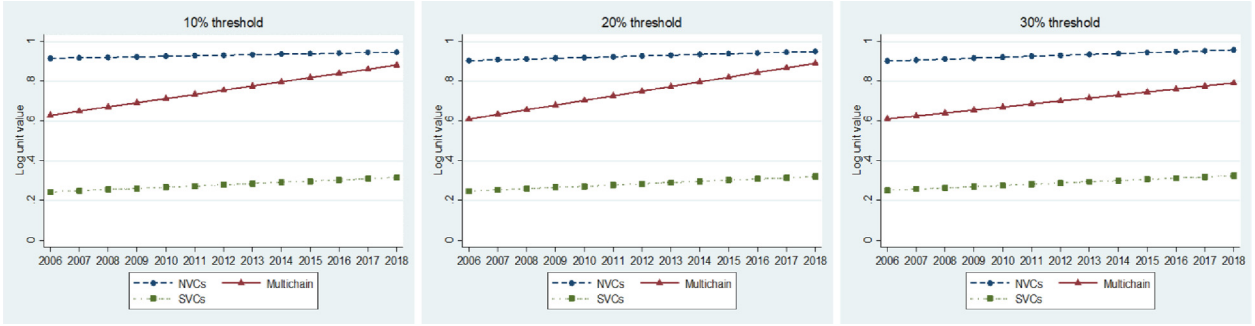

Fig. 5. Unit values, linear trends for multichain and single-chain suppliers (10%, 20%, 30% thresholds) Source: authors' compilation based on KRA dataset.

Table 2
Product diversification, multichain vs. single-chain suppliers, 2006 to 2018.

	Product diversification (multichain strategy 10%)			Product diversification (multichain strategy 20%)			Product diversification (multichain strategy 30%)		
	OLS	MLR	MLR+	OLS	MLR	MLR+	OLS	MLR	MLR+
NVCs*Time	−0.011	−0.004	−0.003	−0.013	−0.002	−0.006	−0.030	−0.011	−0.003
	(0.014)	(0.010)	(0.011)	(0.019)	(0.011)	(0.012)	(0.026)	(0.013)	(0.015)
SVCs*Time	−0.027*	−0.025**	−0.033***	−0.028*	−0.021*	−0.037***	−0.046*	−0.015	−0.036**
	(0.014)	(0.010)	(0.012)	(0.016)	(0.012)	(0.013)	(0.025)	(0.014)	(0.016)
Time	0.027**	0.025**	0.015	0.031*	0.020*	0.019	0.048**	0.014	0.017
	(0.013)	(0.010)	(0.011)	(0.018)	(0.011)	(0.013)	(0.025)	(0.013)	0.016)
NVCs (2006)	−0.459***	−0.357***	−0.048	−0.421***	−0.399***	−0.082	−0.310*	−0.422***	−0.078
	(0.114)	(0.084)	(0.091)	(0.133)	(0.092)	(0.102)	(0.164)	(0.104)	(0.128)
SVCs (2006)	−0.497***	−0.289***	0.147	−0.474***	−0.324***	0.138	−0.364**	−0.340***	0.147
	(0.113)	(0.082)	(0.097)	(0.133)	(0.095)	(0.111)	(0.159)	(0.106)	(0.131)
Network size	–	–	0.418***	–	–	0.418***	–	–	0.422***
			(0.020)			(0.020)			(0.020)
Intermediaries	–	–	−0.003	–	–	−0.002	–	–	−0.001
			(0.045)			(0.045)			(0.045)
Network stability	–	–	0.221***	–	–	0.222***	–	–	0.221***
			(0.041)			(0.041)			(0.041)
Export volume	–	–	0.060***	–	–	0.061***	–	–	0.060***
			(0.008)			(0.008)			(0.008)
EPZ	–	–	−0.279**	–	–	−0.262**	–	–	−0.255**
			(0.119)			(0.120)			(0.123)
Firm and year random slopes	NO	YES	YES	NO	YES	YES	NO	YES	YES
Sd time (firms' slopes)	–	0.060***	0.061***	–	0.059***	0.060***	–	0.060***	0.060***
Sd constant (firms' intercepts)	–	0.593***	0.531***	–	0.594***	0.529***	–	0.598***	0.528***
Observations	5,918	5,918	3,374	5,918	5,918	3,374	5,918	5,918	3,374
R-squared / ICC	0.06	0.54	0.59	0.05	0.54	0.59	0.04	0.54	0.59

Notes: SEs clustered by firm. P-values (***, **, * indicate significance at 1%, 5% and 10% levels respectively). Year fixed effects and lagged control variables are not reported in the MLR + iterations. The interclass correlation coefficient (ICC) indicates the proportion of the variance explained by the firm-year grouping.

usually export to Europe and the Middle East.' (S-5, Athi River, September 2019)

Interviews provided us with a more nuanced understanding of how multichain strategies affect product diversification. Seven medium-large and two small suppliers reported that serving multiple markets with different seasonality and consumer preferences enabled them to widen the range of products they supply. For instance, starting as a mango exporter in 2008, S-2 has leveraged new markets to gradually expand into avocadoes, cashew, and pawpaw. As of 2018, the company export markets were quite differentiated, including a 46% share in the EU, 43% in the UAE and Saudi Arabia, and 11% in Egypt and Libya, while the same share was over 70% to Europe 10 years ago:

'To Europe we send mostly certified Hass avocadoes from March to September. The Middle East buys almost only Fuerte avocadoes and mangoes, which grow from December to March. With time our established clients started asking for other products such as pawpaw and cashew.' (S-2, Nairobi, October 2019)

Another critical factor linked to product diversification across NVCs and SVCs is mitigating risk and increasing control over their supply chain – this is reported by five medium-large suppliers and all three small suppliers. For instance, S-8 stated:

'It is not just about how much money you can make today, but you want to know you can be in business in 3 years' time... Before it was just Europe, if they let you down it's over... You want buyers that buy different products in Europe, Africa, and Asia... You have more choice, more control...' (S-8, Nairobi, September 2019)

Similarly, a small supplier S-11 reported:

'Europe was our biggest market till 2012, but it was costly and risky.... We turned to our friends in India and the subcontinent, who were demanding Asian vegetables like okra, that for us were easy and cheap to grow. Selling to them [India] helped us a lot. We are now able to depend less on one market' (S-11, Machakos, September 2019)

Overall, the quantitative evidence suggests that multichain suppliers diversify products more than SVCs single-chain suppliers, yet not significantly more than NVCs ones. Qualitative statements reinforce this evidence and further point to the critical role of multichain strategies in improving suppliers' ability to differentiate production and allude to the higher flexibility and control that multichain suppliers exert on their value chains.

4.2.2. Value-added tasks: Product sophistication

The coefficients of *NVCs*Time* and *SVCs*Time* suggest that multichain suppliers have mixed experiences of product sophistication compared to single-chain suppliers (Table 3). Up to a 20% threshold, multichain firms show greater upgrading than SVCs single-chain suppliers, though with low levels of significance in the MLR + . No significance difference emerges vis-à-vis NVCs single-chain suppliers. The fact that coefficients remain positive for suppliers selling into NVCs and negative for those selling into SVCs, suggests the effect we observe relative to multichain firms is likely dependent on Northern buyers demanding more sophisticated products relative to Southern buyers. This is in line with existing literature arguing that Southern buyers demand comparatively less sophisticated products, and therefore their suppliers often focus more on upstream processing compared to suppliers selling to the North (Kaplinsky et al., 2011).

Our interviews pointed to varied associations between multichain strategies and product sophistication. For instance, all small/medium firms alluded to the fact that most of the products they export are fresh rather than processed, limiting potential for product sophistication:

Table 3
Product sophistication, multichain vs. single-chain suppliers, 2006 to 2018.

	Product sophistication (multichain strategy 10%)			Product sophistication (multichain strategy 20%)			Product sophistication (multichain strategy 30%)		
	OLS	MLR	MLR+	OLS	MLR	MLR+	OLS	MLR	MLR+
NVCs*Time	0.000	0.002	0.001	0.004	0.003	0.001	0.008	0.006**	0.008
	(0.02)	(0.002)	(0.003)	(0.004)	(0.002)	(0.003)	(0.006)	(0.003)	(0.005)
SVCs*Time	−0.013***	−0.008***	−0.006*	−0.010**	−0.007***	−0.006*	−0.005	−0.003	−0.001
	(0.004)	(0.003)	(0.004)	(0.004)	(0.003)	(0.004)	(0.006)	(0.003)	(0.005)
Time	0.009**	0.005***	0.005	0.006	0.004*	0.006	0.001	0.001	0.001
	(0.004)	(0.002)	(0.003)	(0.004)	(0.002)	(0.003)	(0.006)	(0.003)	(0.004)
NVCs (2006)	0.000	−0.003	−0.013	−0.010	−0.011	−0.009	−0.043	−0.042*	−0.058
	(0.025)	(0.017)	(0.027)	(0.027)	(0.020)	(0.031)	(0.043)	(0.025)	(0.036)
SVCs (2006)	0.087***	0.055***	0.039	0.075**	0.046**	0.038	0.042	0.017	−0.009
	(0.027)	(0.019)	(0.032)	(0.030)	(0.021)	(0.031)	(0.045)	(0.026)	(0.037)
Network size	–	–	0.014**	–	–	0.014**	–	–	0.014**
			(0.006)			(0.006)			(0.006)
Intermediaries	–	–	0.052**	–	–	0.051**	–	–	0.052**
			(0.023)			(0.023)			(0.022)
Network stability	–	–	0.023	–	–	0.023	–	–	0.023
			(0.016)			(0.016)			(0.016)
Export volume	–	–	−0.014***	–	–	−0.014***	–	–	−0.014***
			(0.003)			(0.003)			(0.003)
EPZ	–	–	0.231***	–	–	0.232***	–	–	0.233***
			(0.085)			(0.085)			(0.085)
Firm and year random slopes	NO	YES	YES	NO	YES	YES	NO	YES	YES
Sd time (firms' slopes)	–	0.028***	0.026***	–	0.028***	0.026***	–	0.028***	0.026***
Sd constant (firms' intercepts)	–	0.200***	0.193***	–	0.200***	0.193***	–	0.201***	0.193***
Observations	5,918	5,918	3,374	5,918	5,918	3,374	5,918	5,918	3,374
R-squared / ICC	0.018	0.58	0.62	0.018	0.58	0.62	0.019	0.59	0.62

Notes: SEs clustered by firm. P-values (***, **, * indicate significance at 1%, 5% and 10% levels respectively). Year fixed effects and lagged control variables are not reported in the MLR + iterations. The ICC indicates the proportion of the variance explained by the firm-year grouping.

> 'It is difficult for us to sell frozen products like garden peas or avocadoes, as we need to own cold stores, freezing chemicals and packaging plants, which we cannot afford…' (S-9, Nairobi, September 2019)

Conversely, three of eight large suppliers explained how employing multichain strategies engendered product sophistication. For instance, S-7, an exporter of fruits and vegetables with over 500 ha of cultivated land, highlighted:

> 'UAE, Russia, China, and South Africa are becoming important buyers. We want to be able to combine these markets with Europe, and process products to serve them. We ventured into organic and frozen production… […] It is a good idea, it helps us be more adaptable to any market changes, which we could not do if we only sold to one market…' (S-7, Naivasha, September 2019)

Overall, evidence of product sophistication linked to firms' multichain strategies is only partial and inconsistent, with quantitative data demonstrating no significant link between the two. Qualitative accounts from large exporters indicate that, at times, multichain strategies can promote investments in product sophistication, yet this does not hold for smaller suppliers.

4.2.3. Economic returns: Unit values

The negative and significant coefficients for *NVCs*Time* and *SVCs*Time,* across both MLR and MLR + at 10% and 20% thresholds, indicate that multichain suppliers experienced a steeper increase in unit values vis-à-vis both NVCs and SVCs single-chain suppliers (Table 4). This outcome suggests *suppliers' multichain strategies at 10% and 20% threshold, lead to larger economic returns compared to single-chain strategies.* Nevertheless, as multichain suppliers strategically increase their volume of sales above the 30% threshold, the coefficients for *NVCs*Time* and *SVCs*Time* become insignificant. To the extent that the coefficients are lower than those at the 10% and 20% thresholds, this could imply that economic returns accruing to multichain firms may not be incremental after the 30% threshold.

In Table 4, network size and stability have a significant and positive effect on unit values. This is expected, since more stable buyer–supplier interactions are more likely to involve knowledge transfer, resulting in better products that attract higher prices (e.g. Navas-Alemán, 2011). A wider network also facilitates supplier access to multiple sources of knowledge, with potentially positive repercussions on prices.

Results in Table 4 are supported by interviews with multichain suppliers. Five medium-large and two small suppliers reported that a key factor driving their adoption of multichain strategies was the deterioration in their relationships with Northern buyers. This was mainly attributable to short-term contracts, changing regulations in the EU, and increasingly low prices received:

> 'UK supermarkets paid more in the early 2000s. Since 2010 prices have remained the same or even fallen. Now, with Europe's rules on minimum residual levels tightening and our expenses rising, it become very hard to turn a profit. We started looking elsewhere to Saudi and the Emirates [UAE] to get better prices…' (S-10, Nairobi, August 2019)

Thus, multichain firms began diverting produce destined for the North towards SVCs. Six medium-large and two small suppliers explained that over time, this approach has improved their bargaining position and given them a competitive edge over single-chain suppliers. For instance, S-2 employs 50 permanent staff alongside 60 seasonal workers and is the country's 5th largest avocado exporter. According to their manager, exporting to Europe required the firm to invest in traceability, product selection,[12]

[12] For green beans, this normally includes moisture and size controls, followed by an attentive screening of colour, maturity, insect damaging, and other defects. For avocadoes, products are evaluated based on size (this process is usually automated using a size detector), maturity, and the presence of defects due to damages and pests.

Table 4
Unit values, multichain vs. single-chain suppliers, 2006 to 2018.

	Unit values (multichain strategy 10%)			Unit values (multichain strategy 20%)			Unit values (multichain strategy 30%)		
	OLS	MLR	MLR+	OLS	MLR	MLR+	OLS	MLR	MLR+
NVCs*Time	−0.025**	−0.019**	−0.027**	−0.024**	−0.020*	−0.039**	−0.020	−0.007	−0.020
	(0.011)	(0.009)	(0.012)	(0.012)	(0.012)	(0.017)	(0.017)	(0.016)	(0.021)
SVCs*Time	−0.003	−0.016*	−0.032**	−0.004	−0.017**	−0.046***	−0.002	−0.006	−0.029
	(0.013)	(0.009)	(0.013)	(0.015)	(0.008)	(0.016)	(0.018)	(0.016)	(0.020)
Time	0.024**	0.029***	0.020*	0.025**	0.029***	0.032**	0.023	0.019	0.016
	(0.011)	(0.009)	(0.011)	(0.013)	(0.011)	(0.016)	(0.017)	(0.015)	(0.020)
NVCs (2006)	0.349***	0.289***	0.399***	0.382***	0.278***	0.494***	0.387***	0.254*	0.444**
	(0.082)	(0.071)	(0.092)	(0.090)	(0.097)	(0.134)	(0.134)	(0.138)	(0.175)
SVCs (2006)	−0.729***	−0.379***	−0.234**	−0.676***	−0.375***	−0.122	−0.652***	−0.394***	−0.179
	(0.105)	(0.077)	(0.104)	(0.111)	(0.099)	(0.125)	(0.147)	(0.138)	(0.170)
Network size	–	–	0.200***	–	–	0.199***	–	–	0.200***
			(0.027)			(0.027)			(0.027)
Intermediaries	–	–	0.050	–	–	0.049	–	–	0.057
			(0.076)			(0.076)			(0.076)
Network stability	–	–	0.238***	–	–	0.245***	–	–	0.250***
			(0.058)			(0.057)			(0.057)
Export volume	–	–	−0.113***	–	–	−0.114***	–	–	−0.114***
			(0.016)			(0.017)			(0.016)
EPZ	–	–	0.487**	–	–	0.449*	–	–	0.459*
			(0.222)			(0.238)			(0.242)
Firm and year random slopes	NO	YES	YES	NO	YES	YES	NO	YES	YES
Sd time (firms' slopes)	–	0.104***	0.110***	–	0.104***	0.110***	–	0.104***	0.110***
Sd constant (firms' intercepts)	–	1.117***	1.130***	–	1.121***	1.132***	–	1.123***	1.134***
Observations	5,918	5,918	3,374	5,918	5,918	3,374	5,918	5,918	3,374
R-squared / ICC	0.15	0.73	0.83	0.15	0.73	0.83	0.15	0.73	0.83

Notes: SEs clustered by firm. P-values (***, **, * indicate significance at 1%, 5% and 10% levels respectively). Year fixed effects and lagged control variables are not reported in the MLR + iterations. The ICC indicates the proportion of the variance explained by the firm-year grouping.

and the GlobalGAP certification. Whilst selling into SVCs does not require the same degree of monitoring and standardisation, being GlobalGAP certified enabled the firm to negotiate higher prices with clients in the UAE, Saudi Arabia and North Africa:

> 'When a product is not grade 1, yet it is still GlobalGAP, we can sell it to the Middle East or North Africa. These clients are getting more concerned about traceability. So, we can negotiate slightly higher tariffs and provide them with a range of products from our certified farmers, which we would have to undersell or dump otherwise.' (S-2, Nairobi, September 2019)

Similarly, S-4 indicated that diverting rejected or lower grade green beans from Europe to African countries and the Middle East, led to higher-than-average prices. As articulated by S-4's export manager:

> 'Before we had to sell rejects to the same [European] client at a loss or to occasional traders at very discounted prices. Now we can negotiate better price with clients in the Middle East or locally... This also allowed us to introduce new products and export them all year long... It is a win–win situation.' (S-4, Naivasha, September 2019)

From the 11 interviewed firms, five medium-large and three small suppliers pointed to an immediate link between multichain strategies and higher unit values. By serving more multiple with different consumer preferences and seasonality, suppliers mitigate the risk associated with dependence on one region. This dynamic reduces suppliers' opportunity cost and increases average unit values, since buyers are unable to undercut suppliers and pressure them to undersell their produce:

> 'When we started, we were producing avocadoes for Spain. We now have a network with clients in Dubai, Egypt, Libya, and now even China. Sometimes we offer them products we are already exporting to other markets... If something goes wrong with one client in Europe, we can always sell our products to another one. Since we do this, we never had to discount prices as we used to.' (S-3, Nairobi, September 2019)

In sum, multichain strategies have lowered multichain suppliers' opportunity cost vis-à-vis single-chain suppliers, hence enabling them to achieve higher average prices.

4.2.4. Robustness (OLS and system-GMM)

To further test the robustness of our model, we first present the results of the fully-specified model across all threshold using OLS with firm and time fixed effects (Table 14, appendix). Results confirm the robustness of the MLR+. Second, we perform a two-step system-GMM estimator for the fully-specified model which controls for endogeneity in terms of reverse causality arising from dependent variables, governance variables, and other unobserved factors (Table 15, appendix). The coefficients signs and significance for the interaction terms *NVCs*Time* and *SVCs*Time* from the MLRs are confirmed. These results re-iterate that while unit values tend to improve even past the 30% threshold for multichain firms, this is not necessarily true for product diversification where coefficients turn insignificant at the 30% threshold.

4.3. PSM results

As specified in section 3.2.2, we evaluate the effect of being a multichain firm on product diversification, sophistication, and on unit values by matching multichain and single-chain suppliers who are as similar as possible in all measurable characteristics, except for their multichain status. The outcome of the probit model (Table 5) shows that suppliers who became multichain in year *t* had significantly higher unit values, a larger and less stable network of buyers, a higher probability of engaging in indirect interactions, and were more likely to operate in an EPZ at year *t-1*.

Table 6, column (1), displays the result of OLS controlling for all lagged variables and time fixed effects. The same variables, as per Table 5, are used to determine the propensity scores in Table 6, columns (2), (3), and (4). The coefficients of the PSM suggest that mul-

Table 5
Association of selected characteristics with suppliers' multichain strategy, 2006 to 2018.

	Probability of being multichain at t (10%)	Probability of being multichain at t (20%)	Probability of being multichain at t (30%)
Product diversification (t-1)	0.005	0.009	0.006
	(0.010)	(0.007)	(0.005)
Product sophistication (t-1)	0.021	−0.017	−0.010
	(0.030)	(0.022)	(0.016)
Unit values (t-1)	0.023***	0.008**	0.004
	(0.006)	(0.004)	(0.003)
Network size (t-1)	0.044***	0.020***	0.012**
	(0.010)	(0.007)	(0.005)
Directedness (t-1)	−0.071***	−0.043***	−0.023***
	(0.018)	(0.013)	(0.009)
Network stability (t-1)	−0.125***	−0.082***	−0.069***
	(0.033)	(0.028)	(0.024)
Export volume (t-1)	0.005	0.002	0.002
	(0.003)	(0.003)	(0.002)
EPZ (t-1)	0.082*	0.097***	0.064***
	(0.046)	(0.033)	(0.019)
Observations	3,375	3,375	3,375
Pseudo r-squared	0.10	0.08	0.09

Notes: P-values (***, **, * indicate significance at 1%, 5% and 10% levels respectively). Method of estimation: probit. The reported coefficients correspond to the average marginal effects. The regression specification includes time fixed effects. SEs clustered by firm.

Table 6
Economic upgrading, multichain vs. single-chain suppliers, 2006 to 2018 (PSM).

	(1) OLS			(2) PSM		
	10%	20%	30%	10%	20%	30%
Δ Product differentiation	0.263***	0.285***	0.264***	0.228***	0.248***	0.221***
	(0.040)	(0.045)	(0.062)	(0.035)	(0.040)	(0.049)
Δ Product sophistication	0.004	0.001	0.001	0.003	0.006	0.008
	(0.009)	(0.010)	(0.014)	(0.008)	(0.010)	(0.015)
Δ Unit values	0.071**	0.082**	0.041	0.061**	0.076**	0.030
	(0.029)	(0.036)	(0.047)	(0.026)	(0.032)	(0.037)
	(3) PSM+			(4) PSM++		
	10%	20%	30%	10%	20%	30%
Δ Product differentiation	0.204***	0.234***	0.210***	0.272***	0.316***	0.252***
	(0.037)	(0.038)	(0.055)	(0.047)	(0.065)	(0.068)
Δ Product sophistication	0.005	0.006	0.007	0.006	0.011	0.016
	(0.007)	(0.011)	(0.011)	(0.015)	(0.016)	(0.023)
Δ Unit values	0.062**	0.073**	0.031	0.051	0.091**	0.068
	(0.027)	(0.032)	(0.053)	(0.039)	(0.043)	(0.070)

Notes: P-values (***, **, * indicate significance at 1%, 5% and 10% levels respectively. Both OLS and PSM use time fixed effects. Control and matching variables as per Table 5. Reported coefficients for PSM are computed using gaussian kernel with bootstrapped SEs (sign and significance are consistent when using nearest-neighbour method with and without replacement). Δ indicates the differential at time *t* and *t-1*.

tichain firms experienced a steeper growth in product differentiation and unit values relative to single-chain firms. Nevertheless, we do not observe any significant difference in product sophistication. This outcome is consistent as we progressively change the comparison groups in Table 6, columns (3) and (4). Once we restrict the comparison to firm that became multichain at time *t* with firms that retained their single-chain status (PSM++), the coefficient for unit value for the 10% threshold turns insignificant; yet, as the threshold is increased to 20%, it becomes positive and significant again. As for the MLR in section 5.2, once the threshold is moved up to 30%, the coefficients for unit values decrease and turn insignificant in all models. For product diversification, while they remain positive and significant, all coefficients drop relative to the 20% threshold.

In sum, the outcomes of PSM confirms the results of the MLRs. Multichain suppliers experienced more upgrading than single-chain firms, which translated into steeper growth in product diversification and unit values. Critically, however, *the benefits of a multichain strategy for firms' upgrading vary depending on the diversification threshold of suppliers, with 20% being the optimal threshold level.*

5. Discussion and conclusion: Implications for GVC research

The geography of GVCs has shifted, with an increasing share of global trade occurring between firms located in the global South. This means that supplier firms in developing countries now have the opportunity to engage in multichain strategies, simultaneously serving lead firms across NVCs and SVCs (Navas-Alemán, 2011; Horner & Nadvi, 2018). This article provides an important contribution to existing GVC literature, which to date has largely focused on upgrading in single value chains – NVCs *or* SVCs. It represents the first study to our knowledge that systematically evaluates the effect of suppliers' multichain strategies on economic upgrading in the horticulture sector. Furthermore, the article represents a first attempt to use transaction-level customs data in combination with firm interviews to assess economic upgrading at the firm-level.

The MLR, system-GMM, and PSM models combined with evidence from 11 supplier interviews suggest that *multichain suppliers achieve more economic upgrading relative to single-chain suppliers*. Yet, we observed some important variations across value-added tasks (product diversification and sophistication) and economic

returns (unit values). On the one hand, we find that that multichain suppliers diversify their products more than single-chain suppliers. Our interviews further highlight how *product diversification* among multichain firms has been enabled by different seasonality and consumer preferences across NVCs and SVCs, and an attempt to reduce dependence on NVCs. On the other hand, evidence showing that multichain suppliers improved *product sophistication* more than single-chain suppliers is mostly insignificant. In relation to firms' economic returns, we find that multichain suppliers outperformed single-chain suppliers across all models. Interviews show that lower opportunity cost have been critical in enabling multichain suppliers to achieve improved economic returns vis-à-vis single-chain suppliers. Importantly, our analysis further highlights the specificities of the horticulture sector, where multichain strategies are inevitably shaped by considerations of product perishability, seasonality, and price shocks that would not apply equally to manufacturing industries.

Overall, our research reveals the need to adopt a geographically sensitive view of *economic upgrading,* which needs to be studied in the context of multiple and overlapping value chains. Whereas previous GVC research has addressed questions of upgrading by considering whether or not suppliers could (or should) enter GVCs, our study concurs with recent contributions by showing that producers increasingly deliberate over possibilities to 'switch chains and/or supply multiple end-markets simultaneously' (Horner & Nadvi, 2018, p. 227). This is not to say that a multichain strategy is always economically beneficial: our analysis quantitatively shows potential limits to the benefits of employing specific multichain strategies after the 30% threshold. Hence, more research is warranted to explore how suppliers adapt their multichain strategies in order to continue upgrading.

This article also suggests that multichain strategies have implications for governance in GVCs. *Governance* is an important factor that affects upgrading (Gereffi et al., 2005). This is confirmed in our quantitative analysis, where we find a significant and positive correlation between our indicators of economic upgrading, suppliers' network size, and the stability of their interaction with buyers. In the existing GVC literature, governance has primarily been understood as a top-down process where lead firms play the 'dominant role' in governing the chain and shaping suppliers' upgrading opportunities (Ponte & Sturgeon, 2014, p. 215). However, as opportunities to engage in multichain strategies arise, suppliers can make strategic choices concerning the volume and quality of products sold, effectively challenging the balance of power vis-à-vis lead firms. For instance, we find that suppliers leverage multichain strategies to negotiate higher prices across SVCs and NVCs, thus alluding to a possible shift towards a *bi-polar* structure where the locus of power is increasingly shared among buyers and suppliers. Based on this observation, future studies can examine the implications of multichain strategies for governance in different value chain contexts.

Due to the nature of our data, this study has focused on private firms. However, governance goes beyond the interaction of private firms to include the role of states and civil society organisations in influencing firms' participation and upgrading in GVCs (Gereffi & Lee, 2016; Horner & Alford, 2019). Future research should also gauge the impact of public policy and civil society campaigns on the terms of firms' inclusion in NVCs and SVCs. In Kenya, this is particularly the case after 2019, since the introduction of KS-1758, a mandatory public standard that requires all producers, traders, and retailers to comply with quality and traceability regulations independent of their market of reference. Despite the fact that up to 2019 (and for the whole 2006–18 period covered by our dataset) standards had been largely dictated by buyers and the country of importation (e.g. EU regulations), this attempt by the Kenyan government to level the playing field and its implications for firms' upgrading deserves further attention.

Another important limitation of our research is that by focusing on suppliers' multichain strategies and their impact on economic upgrading, we do not explore how and why such strategies come about in the first place. Previous studies have long assumed that suppliers' participation in GVCs depends on lead firms' choice to select them depending on competitive dynamics, such as cost-capacities, technological capabilities and strategic location (Gereffi, 2014; De Marchi et al., 2018). Yet, to the extent that the emergence of SVCs reduces entry barriers for suppliers in the global South, the factors affecting firms' decisions to navigate different value chains remain underexplored. It is, however, important to note that under all conditions, our study finds that multichain firms outperform single-chain firms in terms of economic returns. Thus, performing multichain strategies is clearly advantageous in the horticulture sector in Kenya.

The promotion of South-South trade is attracting greater attention from the policy community, and particularly within the African continent, as reflected in the newly ratified African Continental Free Trade Area (World Bank, 2019; Mohanty et al., 2019). From a policy perspective, our findings suggest that the coexistence of value chains with different end-markets can result in significant long-term economic benefits for local firms looking to adopt multichain strategies. Future research should broaden the use of customs data to study firm-level upgrading across multiple firms, countries, regions, and sectors. Whilst our case study provides a nuanced understanding of what shapes suppliers' upgrading in the Kenyan horticultural context, we see significant value in extending this agenda to other sectors and geographical contexts.

CRediT authorship contribution statement

Giovanni Pasquali: Conceptualization, Methodology, Software, Visualization, Investigation, Data curation, Writing - original draft, Writing - review & editing. **Aarti Krishnan:** Conceptualization, Methodology, Investigation, Data curation, Writing - original draft, Writing - review & editing. **Matthew Alford:** Validation, Conceptualization, Writing - original draft, Writing - review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix

Table 7
List of fruits and vegetables included in the analysis (4-digit HS code), total exported value (thousand USD) over the 2006–2018 period, and product sophistication indicator (HPG).

4-digit HS code [6-digit products]	Product	Exported value (thousand USD) 2006–18	HPG
0701 - [2]	Potatoes; fresh or chilled	4,192	0
0702 - [1]	Tomatoes; fresh or chilled	894	0
0703 - [3]	Onions, shallots, garlic, leeks and other alliaceous vegetables; fresh or chilled	54,600	0
0704 - [3]	Cabbages, cauliflowers, kohlrabi, kale and similar edible brassicas; fresh or chilled	37,100	0
0705 - [4]	Lettuce and chicory fresh or chilled	332	0
0706 - [2]	Carrots, turnips, salad beetroot, salsify, celeriac, radishes and similar edible roots; fresh or chilled	8,115	0
0707 - [1]	Cucumbers and gherkins; fresh or chilled	499	0
0708 - [3]	Leguminous vegetables; shelled or unshelled, fresh or chilled	1,070,000	0
0709 - [12]	Vegetables, n.e.s; fresh or chilled (generic / unclassified)	1,310,000	0
0710 - [8]	Vegetables (uncooked or cooked by steaming or boiling in water); frozen	243,000	1
0711 - [5]	Vegetables provisionally preserved; (eg by sulphur dioxide gas, in brine, in sulphur water or in other solutions)	2,454	1
0712 - [6]	Vegetables, dried; whole, cut, sliced, broken or in powder, but not further prepared	2,168	1
0713 - [12]	Vegetables, dried leguminous; shelled, whether or not skinned or split	428,000	0
0714 - [4]	Manioc, arrowroot, salep, Jerusalem artichokes, sweet potatoes and similar roots and tubers with high starch or inulin content; fresh or dried, whether or not sliced or in the form of pellets; sago pith	820	0
0801 - [7]	Nuts, edible; coconuts, Brazil nuts and cashew nuts, fresh or dried, whether or not shelled or peeled	48,100	0
0802 - [16]	Nuts (excluding coconuts, Brazils and cashew nuts); fresh or dried, whether or not shelled or peeled	452,000	0
0803 - [3]	Bananas, including plantains; fresh or dried	829	0
0804 - [5]	Dates, figs, pineapples, avocados, guavas, mangoes and mangosteens; fresh or dried	689,000	0
0805 - [5]	Citrus fruit; fresh or dried	9,532	0
0806 - [2]	Grapes; fresh or dried	255	0
0807 - [3]	Melons (including watermelons) and papaws (papayas); fresh	1,373	0
0808 - [4]	Apples, pears and quinces; fresh	2,639	0
0809 - [6]	Apricots, cherries, peaches, plums and sloes, fresh	146	0
0810 - [7]	Fruit, fresh; n.e.s. (generic / unclassified)	30,600	0
0811 - [3]	Fruit and nuts; uncooked or cooked by steaming or boiling in water, frozen	1,445	1
0812 - [2]	Fruit and nuts provisionally preserved; (eg by sulphur dioxide gas, brine, in sulphur water or in other preservative solutions)	4,366	1
0813 - [5]	Fruit, dried, other than that of heading no. 0801 to 0806; mixtures of nuts or dried fruits of this chapter	730	0
0814 - [1]	Peel of citrus fruit or melons; fresh, frozen dried or provisionally preserved	32	1

Source: authors' compilation based on KRA dataset.

Table 8
Qualitative interviews, multichain suppliers.

Firm acronym [year funded]	Location	Size	Production structure & outgrowers	Main products	Main markets	Standard certifications	Processing
S-1 [2000]	Thika	Large	Own farm (100%): 650ht	Green beans, broccoli, carrots, herbs, chilis, avocadoes	Europe, South Africa, East Asia, Kenya	GlobalGAP; GRASP; ETI Base Code; BRC; HACCP	–
S-2 [2008]	Muranga / Nairobi	Large	Outgrowers (100%): 500 smallholders (70%) 20 medium-large farms (30%)	Avocadoes, mangoes, pawpaws, cashew nuts, pineapples	Europe, Middle East, North Africa	GlobalGAP; BRC	Freezing plant
S-3 [2006]	Nairobi	Medium	Own farm (50%) Outgrowers (50%): medium-large farms	Avocadoes, mangoes, green beans, passion fruit, garden peas, herbs	Middle East, North Africa, Asia, Europe	GlobalGAP; HACCP; BRC	Freezing plant
S-4 [1960]	Naivasha	Large	Outgrowers (100%): 200 smallholders (10%) 20 + medium-large farms (90%)	Green beans, peas, broccoli, mangoes, avocadoes	Europe, Middle East, South Africa	GlobalGAP; ETI Base Code; HACCP; BRC	–
S-5 [2004]	Athi River	Large	Own farm (20%) 120ht Outgrowers (80%): 400 + smallholders (40%) 10 + medium-large farms (30%)	Avocado, green beans, garlic, ginger, snow peas, mangoes	Europe, South Africa, Middle East, Kenya	GlobalGAP; BRC	–
S-6 [2013]	Nairobi	Medium	Outgrowers (100%): 80 + medium-large farms	Garden peas, snow peas, green beans, avocadoes	Europe, Middle East, Kenya	GlobalGAP; ASAP	–
S-7 [1966]	Naivasha	Large	Own farm (50%): 250ht Outgrowers (50%): 200 smallholders (10%) 20 + large medium-large farms (40%)	Avocadoes, green beans, broccoli, carrots, herbs	Middle East, Europe, China, India, Russia	GlobalGAP; HACCP	Freezing plant
S-8 [1996]	Meru / Nairobi	Large	Own farm (marginal): 10ht Outgrowers (99%): 10,000 smallholders (70%), 30 + medium-large farms (30%)	Green beans, avocadoes, mangoes, bananas, sweet potatoes	Europe, South Africa, East Africa, Kenya	GlobalGAP; BRC	Canning plant
S-9 [1994]	Nairobi	Small	Outgrowers (100%): via local brokers sourcing from smallholders	Green beans, Avocadoes, mangoes, Asian vegetables	Europe, Middle East	GlobalGAP	–
S-10 [2004]	Nairobi	Small	Own farm (10%) Outgrowers (90%): via local brokers sourcing from smallholders	Green beans, Peas, Mangoes, Avocadoes, Asian vegetables	Europe, Middle East, India, China	GlobalGAP	–
S-11 [2002]	Machakos	Small	Outgrowers (100%): via local brokers sourcing from smallholders	Green beans, Avocadoes, Mangoes	Europe, Middle East, China	GlobalGAP	–

Notes: size is based on Kenya legal classification (large is above 250 employees, medium is 50–250 employees, and small is under 50 employees). S1-S8 suppliers own a packhouse.
Source: authors' compilation.

Table 9
Main themes from interviews with multichain suppliers.

Product diversification	Product sophistication	Unit values
Different seasonality and consumer preferences across NVCs and SVCs [9]	Introducing the production of frozen vegetables to cater for emerging Asian markets [3]*	Standard spillover from NVCs to SVCs leading to improved bargaining position and higher average prices [8]
Long-term relationships with buyers across NVCs and SVCs facilitate diversification [8]	No product sophistication linked to multichain strategies [7]	Deterioration of relationship with buyers in NVCs due to lowering prices [7]
Improving flexibility and reduce risk derived from dependence on NVCs [9]	–	Leveraging emerging SVCs to negotiate higher prices in NVCs [6]
Higher profits through product diversification across NVCs and SVCs [5]	–	Multichain strategies have led to higher profits [8]

Notes: *valid across product diversification and sophistication. Number of responses for each theme reported in brackets.
Source: authors' compilation based on interviews with eight multichain suppliers.

Table 10
Percentage distribution of Kenyan horticultural suppliers: single-chain (NVCs, SVCs) and multichain, 2006 to 2018.

	10% threshold			20% threshold			30% threshold		
	NVCs	SVCs	Multi	NVCs	SVCs	Multi	NVCs	SVCs	Multi
2006	48.0%	43.4%	8.6%	49.6%	44.1%	6.3%	51.2%	44.9%	3.9%
2007	45.8%	46.5%	7.8%	47.3%	48.5%	4.3%	48.8%	49.5%	1.8%
2008	40.7%	51.9%	7.4%	42.6%	53.5%	4.0%	43.7%	54.9%	1.4%
2009	41.9%	49.8%	8.4%	45.2%	50.2%	4.5%	46.4%	51.7%	1.9%
2010	38.7%	51.5%	9.7%	40.9%	51.9%	7.1%	42.0%	52.8%	5.2%
2011	36.0%	56.9%	7.2%	37.7%	57.8%	4.4%	38.5%	59.0%	2.5%
2012	41.9%	51.8%	6.2%	44.3%	52.7%	3.0%	44.7%	52.9%	2.4%
2013	43.3%	48.8%	7.8%	46.1%	49.9%	4.0%	47.1%	51.2%	1.7%
2014	47.7%	42.8%	9.5%	50.9%	43.6%	5.5%	53.1%	44.2%	2.6%
2015	53.3%	38.1%	8.5%	56.5%	39.4%	4.2%	57.1%	40.2%	2.7%
2016	49.3%	40.5%	10.2%	51.8%	41.0%	7.1%	53.9%	41.6%	4.4%
2017	49.9%	38.4%	11.7%	52.7%	39.4%	7.9%	54.6%	40.7%	4.7%
2018	50.7%	38.8%	10.4%	53.0%	40.7%	6.3%	55.0%	41.2%	3.7%

Notes: in each threshold, 'Multi' indicates multichain suppliers, NVCs indicates single-chain suppliers selling into NVCs, and SVCs indicates single-chain suppliers selling into SVCs.
Source: authors' compilation based on KRA dataset.

Table 11
Percentage distribution of total exported value by Kenyan horticultural suppliers: single-chain (NVCs, SVCs) and multichain, 2006 to 2018.

	10% threshold			20% threshold			30% threshold		
	NVCs	SVCs	Multi	NVCs	SVCs	Multi	NVCs	SVCs	Multi
2006	84.0%	7.8%	8.2%	87.6%	7.9%	4.5%	88.5%	7.9%	3.7%
2007	75.8%	16.1%	8.1%	80.2%	16.5%	3.3%	81.9%	17.4%	0.7%
2008	81.6%	9.3%	9.1%	86.8%	9.6%	3.5%	89.3%	10.5%	0.2%
2009	75.5%	7.1%	17.4%	88.9%	7.1%	3.9%	90.9%	7.8%	1.3%
2010	62.4%	20.0%	17.6%	74.9%	20.0%	5.1%	76.4%	20.6%	2.9%
2011	72.5%	11.8%	15.7%	82.5%	11.9%	5.6%	87.0%	11.9%	1.0%
2012	68.1%	10.4%	21.5%	82.1%	12.9%	5.0%	86.1%	13.1%	0.8%
2013	62.1%	21.5%	16.4%	66.1%	25.3%	8.6%	73.4%	26.0%	0.6%
2014	65.5%	22.1%	12.4%	70.2%	23.4%	6.4%	71.2%	23.6%	5.2%
2015	63.6%	18.4%	18.0%	68.8%	24.6%	6.6%	68.9%	25.1%	6.0%
2016	59.0%	23.7%	17.3%	61.7%	30.1%	8.2%	63.0%	30.9%	6.2%
2017	68.1%	12.7%	19.2%	70.9%	21.1%	8.0%	72.2%	22.0%	5.8%
2018	66.6%	15.5%	17.9%	69.8%	17.1%	13.0%	72.0%	17.6%	10.4%

Notes: in each threshold, 'Multi' indicates multichain suppliers, NVCs indicates single-chain suppliers selling into NVCs, and SVCs indicates single-chain suppliers selling into SVCs.
Source: authors' compilation based on KRA dataset.

Table 12
Countries of destination: single-chain (NVCs, SVCs) and multichain, 2006 to 2018.

	10% threshold	20% threshold	30% threshold
NVCs	UK (45.8%); Netherlands (21.2%); France (11%); US (8.2%); Germany (3.5%)	UK (44.1%); Netherlands (20.5%); France (10.3%); US (8.2%); Germany (3.3%)	UK (44.4%); Netherlands (20.1%); France (10.1%); US (8%); Germany (3.2%)
SVCs	India (21.3%); UAE (18.1%); Uganda (9.4%); Pakistan (8.8%); Somalia (8.3%)	UAE (28%); India (24.3%); Uganda (8.1%); Pakistan (7.8%); Somalia (7.2%)	UAE (28.1%); India (23.7%); Uganda (7.9%); Pakistan (7.6%); Somalia (7%)
Multichain	UAE (38.5%); UK (19.9%); South Africa (8.6%); Netherlands (8.6%); China/HK (5%)	UAE (45.2%); UK (22.1%); China/HK (7%); Netherlands (6,2%); Egypt (2.5%)	UAE (58.1%); China/HK (8.6%); Netherlands (7.6%); UK (6.3%); Egypt (2.6%)

Notes: percentages calculated based on share of total value over the 2006–18 period. In each threshold, 'Multi' indicates multichain suppliers, NVCs indicates single-chain suppliers selling into NVCs, and SVCs indicates single-chain suppliers selling into SVCs.
Source: authors' compilation based on KRA dataset.

Table 13
Mean and standard deviation for multichain and single-chain firms, 2006 to 2018 (10%, 20% and 30% threshold) – standard deviation in brackets.

		10% threshold			20% threshold			30% threshold		
		NVCs	SVCs	Multi	NVCs	SVCs	Multi	NVCs	SVCs	Multi
Dependent variables	Product diversification	0.910	0.777	1.441	0.937	0.791	1.443	0.953	0.799	1.477
		(0.843)	(0.852)	(0.906)	(0.858)	(0.856)	(0.899)	(0.864)	(0.856)	(0.959)
	Product sophistication	0.118	0.113	0.116	0.120	0.112	0.102	0.120	0.111	0.105
		(0.269)	(0.268)	(0.245)	(0.272)	(0.266)	(0.213)	(0.272)	(0.265)	(0.212)
	Unit values	1.131	0.188	0.947	1.132	0.199	0.908	1.132	0.208	0.878
		(0.895)	(1.324)	(0.696)	(0.886)	(1.315)	(0.674)	(0.880)	(1.306)	(0.704)
Control variables	Network stability	0.178	0.154	0.143	0.177	0.154	0.130	0.176	0.154	0.118
		(0.250)	(0.283)	(0.152)	(0.246)	(0.281)	(0.151)	(0.244)	(0.280)	(0.136)
	Intermediaries	0.749	0.673	0.643	0.743	0.669	0.636	0.741	0.667	0.628
		(0.404)	(0.431)	(0.417)	(0.406)	(0.431)	(0.418)	(0.406)	(0.431)	(0.424)
	Network size	1.107	0.760	2.013	1.159	0.787	1.972	1.187	0.806	1.945
		(1.047)	(0.893)	(0.987)	(1.067)	(0.915)	(0.975)	(1.080)	(0.923)	(0.964)
	Export volume	9.838	8.992	11.262	9.938	9.041	11.047	9.974	9.075	11.011
		(2.888)	(3.126)	(2.413)	(2.885)	(3.134)	(2.440)	(2.880)	(2.534)	(2.534)
	EPZ	0.017	0.004	0.033	0.018	0.004	0.040	0.018	0.005	0.046
		(0.127)	(0.063)	(0.171)	(0.129)	(0.065)	(0.188)	(0.130)	(0.069)	(0.199)

Source: authors' compilation based on KRA dataset.

Table 14
Economic upgrading, multichain vs. single-chain suppliers, 2006 to 2018 (OLS with firm and time fixed effects).

	Unit values			Product diversification			Product sophistication		
	10%	20%	30%	10%	20%	30%	10%	20%	30%
NVCs*Time	−0.026**	−0.034**	−0.034	−0.003	−0.009	−0.022	0.003	0.004	0.006
	(0.012)	(0.017)	(0.022)	(0.015)	(0.017)	(0.022)	(0.004)	(0.007)	(0.008)
SVCs*Time	−0.044***	−0.051**	−0.050**	−0.048***	−0.054***	−0.068***	−0.012**	−0.011	−0.009
	(0.016)	(0.020)	(0.024)	(0.017)	(0.018)	(0.024)	(0.006)	(0.007)	(0.008)
Time	0.027**	0.036*	0.038	0.031*	0.037**	0.051**	0.008	0.008	0.006
	(0.014)	(0.019)	(0.024)	(0.016)	(0.018)	(0.025)	(0.005)	(0.007)	(0.009)
NVCs (2006)	0.333***	0.415***	0.474**	−0.076	−0.137	−0.021	0.001	−0.009	−0.016
	(0.108)	(0.149)	(0.211)	(0.118)	(0.126)	(0.149)	(0.048)	(0.073)	(0.081)
SVCs (2006)	0.073	0.133	0.160	0.256*	0.238	0.342**	0.082	0.064	0.052
	(0.132)	(0.154)	(0.210)	(0.132)	(0.144)	(0.164)	(0.053)	(0.066)	(0.073)
Network stability	0.085	0.093	0.095	0.110**	0.110**	0.107**	0.020	0.021	0.021
	(0.076)	(0.075)	(0.075)	(0.050)	(0.050)	(0.049)	(0.021)	(0.021)	(0.021)
Intermediaries	0.042	0.047	0.051	0.062	0.059	0.066	0.015	0.012	0.012
	(0.130)	(0.130)	(0.129)	(0.071)	(0.071)	(0.072)	(0.036)	(0.036)	(0.036)
Network size	0.192***	0.193***	0.192***	0.355***	0.353***	0.360***	0.017*	0.016	0.016
	(0.034)	(0.034)	(0.034)	(0.028)	(0.028)	(0.028)	(0.010)	(0.010)	(0.010)
Export volume	−0.110***	−0.111***	−0.111***	0.084***	0.085***	0.083***	−0.016***	−0.016***	−0.016***
	(0.020)	(0.021)	(0.021)	(0.014)	(0.014)	(0.014)	(0.004)	(0.004)	(0.004)
EPZ	−0.034	−0.073	−0.075	−0.113	−0.084	−0.081	−0.094	−0.100	−0.10
	(0.155)	(0.172)	(0.168)	(0.158)	(0.149)	(0.145)	(0.066)	(0.069)	(0.068)
Observations	3374	3374	3374	3374	3374	3374	3374	3374	3374
Firm and year fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES
R-squared (within)	0.08	0.08	0.08	0.36	0.36	0.36	0.06	0.06	0.06

Notes: SEs clustered by firm. P-values (***, **, * indicate significance at 1%, 5% and 10% levels respectively). Year fixed effects and lagged control variables are not reported.

Table 15
Economic upgrading, multichain vs. single-chain suppliers, 2006 to 2018 (two-step system-GMM).

	Unit values			Product diversification			Product sophistication		
	10%	20%	30%	10%	20%	30%	10%	20%	30%
NVCs*Time	−0.029**	−0.042**	−0.038	0.000	0.008	0.022	0.006	0.005	0.005
	(0.014)	(0.019)	(0.025)	(0.013)	(0.017)	(0.021)	(0.005)	(0.006)	(0.008)
SVCs*Time	−0.054***	−0.065***	−0.061**	−0.031**	−0.028**	−0.012	−0.003	−0.004	−0.004
	(0.017)	(0.020)	(0.026)	(0.015)	(0.014)	(0.023)	(0.006)	(0.007)	(0.009)
Time	0.102***	0.113***	0.114***	0.011	0.011	0.001	0.042***	0.042***	0.045***
	(0.032)	(0.033)	(0.035)	(0.022)	(0.023)	(0.025)	(0.009)	(0.010)	(0.010)
NVCs (2006)	0.544***	0.611***	0.661***	−0.102	−0.180	−0.267	0.013	0.004	−0.016
	(0.120)	(0.158)	(0.222)	(0.113)	(0.136)	(0.177)	(0.041)	(0.056)	(0.074)
SVCs (2006)	−0.015	0.056	0.095	0.140	0.108	−0.002	0.017	0.010	−0.015
	(0.139)	(0.167)	(0.231)	(0.124)	(0.146)	(0.185)	(0.048)	(0.058)	(0.077)
Lagged dependent variable	0.316***	0.313***	0.311***	0.374***	0.367***	0.373***	0.346***	0.345***	0.344***
	(0.056)	(0.057)	(0.056)	(0.045)	(0.044)	(0.043)	(0.063)	(0.062)	(0.062)
Network stability	0.201**	0.200**	0.199**	0.104*	0.108*	0.106*	0.005	0.008	0.008
	(0.094)	(0.095)	(0.095)	(0.059)	(0.060)	(0.060)	(0.024)	(0.023)	(0.023)
Intermediaries	−0.006	−0.011	−0.041	−0.006	−0.015	0.007	−0.062	−0.060	−0.064
	(0.133)	(0.136)	(0.136)	(0.083)	(0.084)	(0.085)	(0.043)	(0.044)	(0.043)
Network size	0.248***	0.242***	0.243***	0.377***	0.381***	0.383***	0.035***	0.033***	0.032***
	(0.047)	(0.048)	(0.047)	(0.029)	(0.029)	(0.030)	(0.011)	(0.011)	(0.011)
Export volume	−0.107***	−0.109***	−0.111***	0.075***	0.075***	0.076***	−0.026***	−0.025***	−0.025***
	(0.020)	(0.027)	(0.027)	(0.013)	(0.014)	(0.014)	(0.006)	(0.006)	(0.006)
EPZ	0.500*	0.453	0.440	−0.176	−0.151	−0.140	0.269**	0.262**	0.256**
	(0.294)	(0.323)	(0.316)	(0.228)	(0.228)	(0.234)	(0.121)	(0.123)	(0.123)
Observations	3374	3374	3374	3374	3374	3374	3374	3374	3374
Instruments	189	189	189	189	189	189	189	189	189
AR (1) – Pr > z	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
AR (2) – Pr > z	0.755	0.730	0.572	0.449	0.474	0.401	0.681	0.698	0.654
Hansen test (Pr > chi2)	0.193	0.260	0.379	0.212	0.164	0.148	0.346	0.443	0.357

Notes: SEs clustered by firm. P-values (***, **, * indicate significance at 1%, 5% and 10% levels respectively). Year fixed effects and lagged control variables are not reported.

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