The Net Worth of Networks

Firm-level effects of participating in Global Production Networks: evidence from the Philippines

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Abstract

This paper examines the nature of developing country participation in Global Production Networks based on firm-level data. It contributes to the vast firm heterogeneity in trade literature by empirically unravelling more dimensions of heterogeneity. Introducing a novel approach in exploiting firm-level data, it combines outlier selection, machine learning techniques, firm demographics, and market orientation analyses so as to identify firms more likely to be integrated in global production networks. The paper examines the multitude of ways these globally-integrated exporters differ from the rest of the local firm population. We utilize new and rich firm-level data from the Philippines covering the universe of export and import transactions of all Filipino firms from 1991 till 2012. Our results show that globally-integrated firms are starkly different from traditional exporting firms. They are significantly bigger, both in terms of employment size and revenues; produce and source higher quality and a greater number of exports and imports, respectively; earn relatively larger trade surpluses; export and import to and from more markets; largely foreign-owned; and have high survival rates. Half the number of these firms have also attained a global export coverage (i.e., simultaneously exporting to US, Japan and at least one country in EU12, East Asia, ASEAN, and Rest-of-the-World), in their first exporting year. Empirical results further confirm the widely-held perception of weak upgrading among firms, with product upgrading being largely influenced by macroeconomic variables such as exchange rates. There are no marked changes in the position of Philippine firms over time, but a sort of local *flying-geese* phenomenon is observed as the largely foreign-owned firms in global production networks move out of segments where technological change has increasingly standardized production, and more local firms step in to fill in the niche.

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1. Introduction

It is broadly assumed that greater participation of developing country firms in global and regional production networks would be a way to accelerate industrialization by exposing these firms to new technology and bigger markets, as well as stimulating the formation of a more diversified set of skills. However, as an UNCTAD (2013) report on Global Value Chains pointed out, the often-cited gains of building up the "technological capabilities and productive capacities through GVCs are not automatic", and that contribution to a country's GDP could be limited if it captures only a marginal share of the value added created. Baldwin (2011) echoed similar concerns, pointing out that while the fragmentation of global production has made industrialization less lumpy and therefore more accessible for poor countries, specialization in the labour-intensive and low value-added production has also rendered such industrialization less meaningful for development.

But how does one gauge the pros and cons of participation in global or regional production networks? Conceptually, can shifts in the position of a developing country firm in the international supply chain towards a more upstream or downstream production segment reveal anything about a country's increasing industrial capacities? Antras, Chor, Fally & Hillberry (2012) found that the export activities of poorer countries were slightly more upstream relative to that of richer countries. Costinot, Vogel and Wang (2013), then showed how poor countries could benefit by moving towards more downstream stages of production, which is assumed to generate higher prices and wages, and how such a shift would be facilitated by increasing standardization of production technologies. However, the relationship between the 'upstreamness' of exports and a country's level of income disappears when zooming in on trade in manufactures, where the lowest value segment is actually situated in the middle where the most labour-intensive manufacturing takes place. With such nonlinearities, modelling the various transmission channels that link the position of developing countries in global supply chains on one hand, and overall economic growth on the other, would be anything but straightforward.

Would levels of domestic value-added and/or greater export sophistication be more suitable indicators of success for local supplier firms? Even here, some inconsistencies linger. As Hallak & Schott (2011) showed for instance, countries such as the Malaysia and the Philippines have moved up the product sophistication ladder as measured by conventional indicators (e.g. EXPY-PRODY indices[3]) based on aggregate trade data, but without the expected impact on manufacturing export growth. To begin with, inferring the degree of sophistication from the share of high-tech goods in the country's trade export basket could be misleading since the level of disaggregation of export data is insufficient to capture the pattern of the division of labour between developed and developing countries in a global value chain.

[3] EXPY and PRODY indices measures the sophistication of a country's export basket by linking sectors to the level of income of countries that export these products the most.

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Interpreting trends in domestic value-added is likewise problematic, since a rise or fall would often reflect the nature of the production network a country is integrated in (i.e. more fragmented or not), and therefore not always informative of whether upgrading is taking place. Moreover, as Nenci (2014) points out, the high level of industry aggregation in databases (e.g. OECD-WTO database on Trade in Value-Added (TiVA), UNCTAD Eora GVC database), is one of its problematic weaknesses, not only leading to aggregation biases but also obscuring the understanding of which specific products intricately link which countries together in a network.

An alternative to a sectoral approach of gauging a country's participation in global production networks is to identify the firms active in these networks and compare their performance and behaviour with local firms as well as those that export in traditional modes. To answer the question of whether or not developing country firms 'progress' to higher value-added production segments, one could examine shifts in selected indicators relative to the performance of other foreign affiliated firms in the same production networks. Ideally, firm-level data from multinational firms themselves and their affiliates would provide the means to perform such analyses by tracing shifts in the division of labour of firms as signalled by their exporting and importing behaviour. The performance of non-GPN firms could provide useful counterfactuals, or in the case of those active in similar or adjacent sectors as GPN firms, substantial leaps in productivity could signify the presence of network or positive externality effects. But, such multinational and affiliate data are quite rare and uneven.

A second-best option is to turn to firm-level trade data which have become increasingly accessible in the last decade. The extent and nature of each firm's export and import transactions could provide some indicators of participation in production networks as well as identify the countries more intensively involved as production partners. In this paper, we introduce a novel approach in exploiting firm-level data, which combines outlier selection, machine learning techniques, firm demographics, and market orientation analyses so as to identify firms more likely to be integrated in global production networks and examine the multitude of ways these globally-integrated exporters differ from the rest of the local firm population.

The perennial hurdle in understanding how the division of labour among international firms evolves in vertically integrated sectors is the inability to determine which imported goods enter as inputs in which export product. The production and sourcing behaviour of each firm that can be tracked in firm-level data, however, provides a way to match export products with their import baskets or composites. Rather than begin with a set of priors regarding the kind of sectors or firms that are most likely to be involved in GPNs, one can give full rein to the data to reveal patterns of similarities, which in turn point to the key variables that differentiates GPN firms and sectors from the rest.

Utilizing newly created and rich firm-level transactions data of the Philippines, we develop a firm selection and clustering methodology to scrutinize the behaviour and performance of GPN-integrated

firms in terms of firm survival and empirics of upgrading. We also demonstrate an approach that enables one to capture a 'snapshot' of a GPN, albeit from the perspective of one country alone. The Philippines data covers the universe of export and import transactions of all Filipino firms from 1991 till 2012, matched with the annual surveys of manufacturing firms from 1996 till 2012. Longitudinal panel data of such length and from a developing country at that, is quite rare. The Philippines is also an interesting case because it is one of the low middle-income Asian countries with the highest shares of intermediates in its total trade, that are geared to service regional and global production networks.

Our results show that GPN-integrated firms and the rest of the firm population are worlds apart. Much attention in the literature has been focused on firm heterogeneity following the seminal paper of Melitz (2003). However, enormous differences among firms are often collapsed into the black box of the fixed-effects estimators of standard econometric models. There has been ample research done to understand the differences between exporting and non-exporting firms, but much less interest is given to the distinctions among the pool of exporters themselves. By unveiling the different clusters of firms in the data, we can observe their diversities in several dimensions, such as firm survival, product space, and upgrading or adjustment behaviour. The variation among exporters that we have observed, reveal a highly dualistic structure, separating firms that produce world quality and high-technology products operating within the super highways of global production networks, and those that remain within the comforts of the country's comparative advantage relying mainly on self-built trading networks.

We start out with a brief survey of the literature on GPNs, focusing on the numerous difficulties in capturing its nature and measuring its impact, especially for developing countries such as the Philippines. Section three describes the scope and nature of the data and discusses the methodologies used in firm selection, tracking the position of firms in a production network, and the empirical analysis of upgrading. Section four illustrates the multitude of ways that firms integrated in GPNs differ from the rest of the firm population. The succeeding section looks at the position and upgrading of firms in GPNs and their determinants. The last section summarizes and concludes.

2. Literature Review and Theoretical underpinnings

There are a number of challenging conceptual and measurement issues surrounding the study of GPNs, especially as they relate to industrialization and the overall growth of developing countries. The large literature investigating the consequences of production fragmentation on the pattern, volume and welfare implication of international trade has mostly been centered on developed-country experiences. Moreover, the question tackled has often been the impact of outsourcing the relatively labour-intensive segments of production on rich country workers.[4] From the developing-country perspective, on the

[4] Feenstra & Hanson (1996) looked at the effects of international outsourcing of US firms on the relative demand for skilled labour, while Egger & Egger (2002) asked how international outsourcing influences wages,

other hand, the interest is largely on the impact on market access for exports and technological spill-over, as a double support for accelerating industrial development.

In UNIDO (2002, p.42) participation in GPNs is cited as the main cause of improved industrial performance by increasing the complexity of a country's exports. However, one recurring theme in the literature of Global Value Chains is that the circumstance of developing country firms could instead be precarious: in the same manner that countries could specialize on the right or wrong type of products, developing-country firms could likewise integrate themselves into the right or wrong type of GVCs, certainly from the perspective of the impact on overall growth. Kaplinsky (2004) re-visited the idea of immizerizing growth when firms insert themselves in GVCs that operate in sectors with declining terms of trade (e.g. furniture, toys, footwear), while Gimet et al. (2010) similarly spoke of immizerizing specialization, where poor countries, by being assigned the most labour-intensive stage of production, could become excluded from the more innovative developments in the manufacturing sector as a whole. Baldwin (2011) posed similar arguments, pointing to the firm-specificity of technology transfer, limited learning on design and construction and the propensity of some foreign lead firms to purposely reduce the dissemination of know-how to the local economy to protect their knowledge assets.

The task of upgrading and gaining market niches with higher value-added is certainly not made easier by the current concentration of market power by few buyer firms and first-tier firms. In electronics, a handful of global contract manufacturers dominate the market, and their scale and scope of operations would be difficult to challenge even by developed-country entrants. Kaplinsky and Morris (2001) pointed out that in the context of capturing or maintaining the firms' competitive niches, upgrading and innovation must be pursued at a faster rate relative to their closest competitors. Whittaker et al (2008) referred to the moving target for upgrading as economies on or near the technological frontier innovate at an even faster rate.

Furthermore, the competitive environment has become even more unwelcoming since the scale and technological thresholds firms need to reach to integrate in GVCs, have only further increased in the last decade (Sturgeon & Lester, 2004). As Nabeshima (2004) pointed out, being selected as an Original Equipment Manufacturer (OEM), for instance in electronics is hard enough, since suppliers must already display the production and technological skills that could provide the needed quality, reliability in delivery, within the assigned cost parameters. Low production costs, largely through cheap wages is no longer enough to assure entry. The transition to an Original Design Manufacturer (ODM) is harder still, and a path only firms like Samsung were able to traverse (Brahmbhatt & Hum, 2007).

especially in Eastern Europe. Glass & Saggi (2001) theoretically tackle the impact of GPN participation on innovation, and the work of Amiti & Wei (2006) on international outsourcing in services studies the effects on US productivity. More recently, Gorg & Hanley (2011) analysed the productivity effect of outsourcing using Irish plant-level data.

The increase of competition among foreign lead firms, however, provides an interesting and promising channel for local suppliers. Fujita (2007), for instance, looked at the impact of the entry of Chinese lead firms with internationally recognized brands, on the position of Vietnamese suppliers in the motorcycle value chain. China's engagement served as an exogenous shock, which transformed the Japanese dominated value chains in ways that effectively paved the way for local assemblers to organize new value chains with Chinese firms. The opportunities for upgrading have therefore been significantly increased.

These analyses are reminiscent of the sort of pessimism found in some FDI literature. Goerg and Greenaway (2004), for instance, presented some empirical evidence that local firms often have been unable to reach the threshold of absorptive capacity to take advantage of whatever spill overs FDI might have to offer. Kemeny's (2010) empirical analysis arrived to similar conclusions, citing the importance of "a well-educated workforce, effective communication infrastructure, greater trust, and effective economic, social and political institutions" to capture the FDI dividends. That latecomers encounter far more difficult challenges has also been discussed by Lall (2005). He stresses that the cumulative nature of skill/capability development confer advantages to countries where FDI have already put the virtuous cycle of economies of scale and productivity into motion.

UNCTAD (2013) attempted to empirically test the relationship between GPN participation and economic growth. Countries with the highest rate of change in GPN participation had a median per capita GDP growth of 3.3%, compared to 0.7% of those with little or no increase in participation[5]. No causal relationship could be established, however, so that it remains unclear whether the favourable economic conditions accompanying high growth make it likewise attractive for lead firms to source from these countries, or whether the linkage with global firms serve as catalysts for greater growth.

These studies reveal a considerable methodological barrier for gaining any further insights: how to measure GPN participation in a meaningful and robust manner. Given the extremely limited data on MNC activity and their affiliates worldwide, GPN literature has turned to trade data and national input-output tables to measure the extent of a country's participation in the international network of production. Using UN Comtrade data base, the share of parts and components, and final assembly sector in total trade often act as proxies of GPN participation (Ng & Yeats, 2003; Ando & Kimura, 2005; Yeats, 2011; Athukorala, 2011). Sectors typically identified belong to SITC 7 (Machinery and transport equipment) and SITC 8 (Miscellaneous manufactured articles). Athukorala (2003), for instance, used a list of parts and components covering trade in manufactures, which was drawn by mapping these product groups in the UN Broad Economic Classification (BEC) registry (in the WTO product list) with the 6-digit Harmonized System of trade classification.

[5] GVC participation is defined as the share in a country's total exports of the foreign value-added it uses for its own exports plus the value-added that it contributes to its partners' exports.

Greater interest in a more detailed representation of production network activities between countries has led to increasing use of value-added data derived from national input-output tables. Early work on vertical specialization by Hummels, Ishii & Yi (2001), traced the use of imported inputs in the manufacture of exported goods using input-output tables. The development of various databases that measure the extent of value added by local and foreign firms in a country's exports further increased the possibilities of analysing the nature of these international linkages. The Trade in Value Added (TiVA) database jointly assembled by WTO and OECD, the EU-funded World Input-Output Database (WIOD), the UNCTAD-EORA GVC database, and the IDE-JETRO Asian Input-Output database, are the most prominent examples of these. Various research utilizing these datasets indeed point to a rise in trade in intermediate goods (Baldwin & Lopez-Gonzales, 2014), increase in foreign value-added share (Timmer et al., 2014), particularly in the exports of developing countries (UNCTAD, 2013).

It is tempting to take the growth in the developing-country share of domestic value-added, especially in sectors where GPN are prevalent, as an indicator of 'industrializing specialization'. As Elms & Low (2013) pointed out, while the foreign content in exports is a widely-used proxy for a country's propensity to engage in production networks, the growth of domestic value-added embedded in exports is an attractive measure of the benefits of such engagement, particularly for policymakers. However, Kowalski et al. (2015) referred to this as a narrow view of upgrading, stressing that the volume of activity and implication for employment is as important. Moreover, as Baldwin (2013) argued, domestic value-added is not so much an indicator of industrialization but mostly a yardstick of the degree of offshoring or fragmentation in the export sectors where a country is most active. Anything that will reduce the cost of production, such as the introduction of more developed-country technology or further slicing of the production process, which lowers the unit cost of production, will eventually lead to a lower value-added of the country where the offshored tasks are performed.

The increasing role played by services in production adds another layer of complication to the analysis of domestic value-added and its linkages with upgrading. Baldwin and Lopez-Gonzales (2014) estimated the share of manufacturing and services to be 70 and 20 percent of gross exports, respectively. Measured in value-added, however, each sector account for about 40 percent share (Johnson, 2014). This implies that services have a relatively higher value-added content compared to manufacturing and often account for a larger share of the price of the final goods than that of total contribution of the manufacturing components (Baldwin, 2013). This also explains why in the well-known Stan Shih's *smile curve* depicting the relationship between the stage of production in a GPN and its contribution to value added, the tasks that generate the most value are those associated with services: R & D, product design, advertisement, logistics and distribution. The intermediate stage of manufacturing, instead, brings in the lowest value added. Upgrading in this context is not so much a matter of an up- or downstream shift in production but that of increasing the ability of a firm to produce a better (or higher

quality) variant of an upstream or downstream product, or add more value by assuming more service-related tasks in the GPN.

Instead of describing the position of a country in the global division of labour in terms of its distance from final-good production (as in Fally, 2011 and Antras et al.,2012) or in terms of the ratio of forward and backward average propagation length (APL) (as in Escaith & Inomata, 2008), one can also locate a country's area of specialization along a so-called quality ladder of production. The prevalence of GPNs has been accompanied by a surge in technological innovation that is continuing to introduce product improvements, generating the quality ladders, which have been the subject of many studies since the pioneering work of Grossman & Helpman (1989). If the desired trend of an industrializing economy is to see its firms diversify towards more sophisticated exports, then a useful indicator to track is the shifts in country's position along the quality spectrum.

The measurement of quality, and thus, of upgrading is besieged with difficulties, however. The use of unit value variations has been widely used in the literature to proxy for quality differences (Schott, 2004; Hummels & Klenow, 2005; Hallak, 2006; Bastos & Silva, 2010). Khandelwal (2010) relaxes the strong assumption of a straightforward link between quality and price, by introducing the role of demand or the higher willingness to pay for higher product quality. Since quality is signalled not only by prices but by higher market shares as well, information on quantity can be likewise exploited. Kaplinksy, et al (2009) also pointed out that higher prices may be indicative of production inefficiencies or decline in innovative performance, hence advocating the use of an indicator of cost competitiveness in the form of market shares.

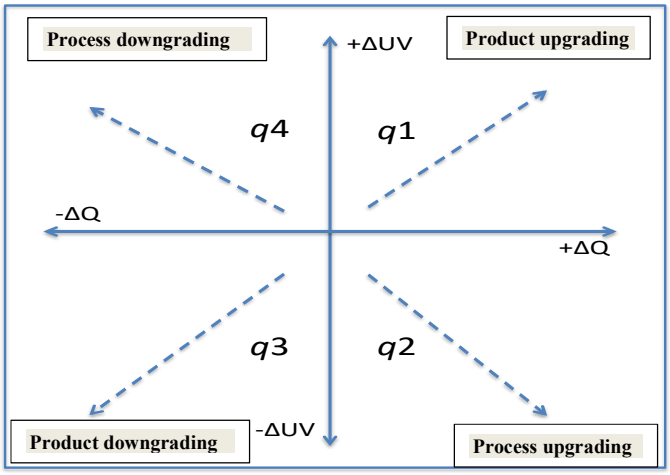
For Comité, Thisse and Vandenbussche (2014), further steps must be taken to filter out the effects of costs and tastes on prices in order to determine the price difference that can be attributed to quality variations. They opt for a mark-up concept that utilizes not only unit prices but also information on variable costs (proxied by product-level mark-ups, inferred indirectly using the Price-Cost-Method), and destination/market-specific taste differences (captured by comparing consumption of substitute products). Vandenbussche (2014) demonstrates the usefulness of this method, for instance in identifying which EU member countries operate in the low or high-quality product segments, and thus which would be more likely to face more wage or cost pressures due to greater competition.

In the context of GPNs, it is good to remember that upgrading often pertains to a shift towards another product within a broader sectoral category. Moving up the quality ladder then assumes a different meaning than the one referred to by the literature cited above. Costs and scale economies would certainly impact on the pricing and sourcing strategies of foreign lead firms, but consumer tastes or the need to escape competition might play a less important role. Transfer-pricing motives, long-term relationships with suppliers and the sunk costs which that entails, or fiscal and other financial incentives

offered by host governments, are just some of the forces that may drive the assignment of production segments across the affiliate firms within a network.

Kaplinsky & Readman (2005) provided a framework for analysing upgrading outcomes using unit prices and market shares as depicted by Figure 1. Positive change in unit value (UV) and volume (Q) are taken to be indicators for product upgrading (quadrant 1); falling unit values and rising volume for process upgrading (quadrant 2); downward trends in both unit values and volume for product downgrading (quadrant 3); and rising unit values with falling volume for process downgrading (quadrant 4). These are obviously rough indicators of upgrading and downgrading given the numerous drivers of changes in demand. Falling prices coupled with rising demand could imply either an increase in efficiency (process upgrading) or a successful revenue-raising strategy through a shift towards a lower quality variety (product downgrading). Conversely, higher unit prices with falling demand could either be due to cost inefficiencies (process downgrading), resulting to a loss of competitiveness, or could be the result of a failed attempt to escape competition by raising product quality (failed product upgrading).

Figure 1 Change in Unit Values (*UV*) & Export Volume (*Q*)



Source: Modified version of Kaplinsky & Readman (2005), figure 1, p. 684.

With respect to locating the position and role of a country with respect to its other partners within a GPN, the task would be greatly facilitated by firm-level trade analysis that could track the composition of products and countries linked within a production network. In theory, one can use what is known about the configuration of tasks in the supply chain of key GPN products and then proceed to investigate the interdependence and dynamics of countries in firms active in the performance of these tasks. In fact, case studies of GPN-driven sectors such as automobiles, furniture, electronics and textiles employ this approach. Applying this on broad trade or value-added data could be extremely laborious, hence the lack of studies that provide a finer resolution of the GPN product-country mix. This is the research

gap that this paper aims to fill by using the exporting and importing behaviour of individual firms as reference point, and exploiting the rich data on prices, quantity, transactions frequency and other firm characteristics derived from a matched firm-survey data of Philippine manufacturing firms.

3.0 Data and methodology

The data set employed here covers all individual firm export and import transactions by Philippine manufacturing firms from 1991 till 2012.[6] Since these are based on customs data, each transaction reports the product code, FOB value in US dollars, insurance and freight costs, and country of destination. The reported trade is at the highest level of product disaggregation (7-digit Philippine Standard Commodity Classification, concorded to 10-digit ASEAN Harmonized Tariff Nomenclature). Additional firm information such as size, ownership, revenue and cost structure are obtained by matching the firm survey data comprising of nine Annual Survey of Establishments (1996, 1998, 2001, 2003, 2005, 2008, 2009, 2010) and three Censuses of 2000, 2006 and 2012. Hence, out of a total of 64,115 exporters, we are able to trace 6,949 manufacturing firms with firm survey data; the rest being active in agriculture and services.[7]

3.1 *Firm Selection Methodology*

The richness of the dataset that spawns 22 years provides a unique opportunity to create different typologies of firms. The aim is to eventually compare the performance of firms belonging to GPNs with those that are not. Figure 2 illustrates the firm selection process which consists of outlier filtering, clustering and firm demographics analyses.[8] From the universe of 108,281 Philippine exporters and importers, we first filtered out firms that export only in one year, all importers that do not export, all exporters that do not import, and non-manufacturing firms.

From the remaining 5,877 firms, we then filtered out the outlier firms based on their propensities to export and import. The firm cluster that displays the highest propensity to export and import is the subject of interest. As Baldwin (2013) points out, the extent of the overlapping of comparative advantage (i.e. extraordinarily large exports) and disadvantage (i.e. large imports) is a good proxy for global supply chains. The set of enterprises that were identified as GPN-participating firms were therefore those that distinctively display outward orientation both in their exporting as well as their input sourcing behaviour.

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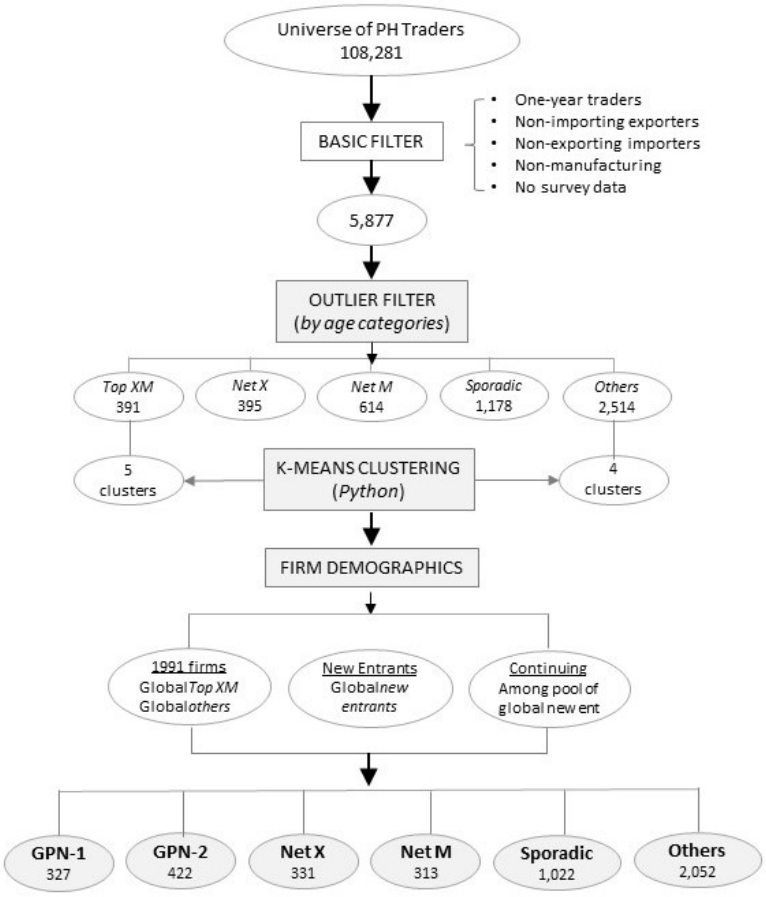
[6] A detailed description of the dataset can be found in Balaoing (2017).

[7] For this section, firms whose main exports are in product categories such as *personal & household effects of travellers & immigrants* (PSCC 9310600), *Machinery and equipment temporarily imported /exported for contractual work* (PSCC 9310503) are further removed in order to capture the upgrading behaviour of firms engaged in production. See technical notes in the appendix on the data preparation for complete list of sectors removed.

[8] The full details of the selection process can be found in Table 1A in the appendix.

Figure 2 Selection Process of Firms in Global Production Networks



We normalize the annual export and import transactions of each firm[9], further grouping firms into 8 age categories[10]. Firms that belong to the top quintile of both export and import transactions are classified as top exporters & importers, *Top XM*. Those that are in the top quintile of exports and lowest of imports are grouped as net exporters, *Net X,* while those in the top quintile of imports and lowest of exports are net importers, *Net M*. We classify as sporadic traders, *Sporadic,* those that belong to the lowest quintile of both exports and imports. The rest are classified as *Others*, which lumps together firms that have intermediate trading propensities.

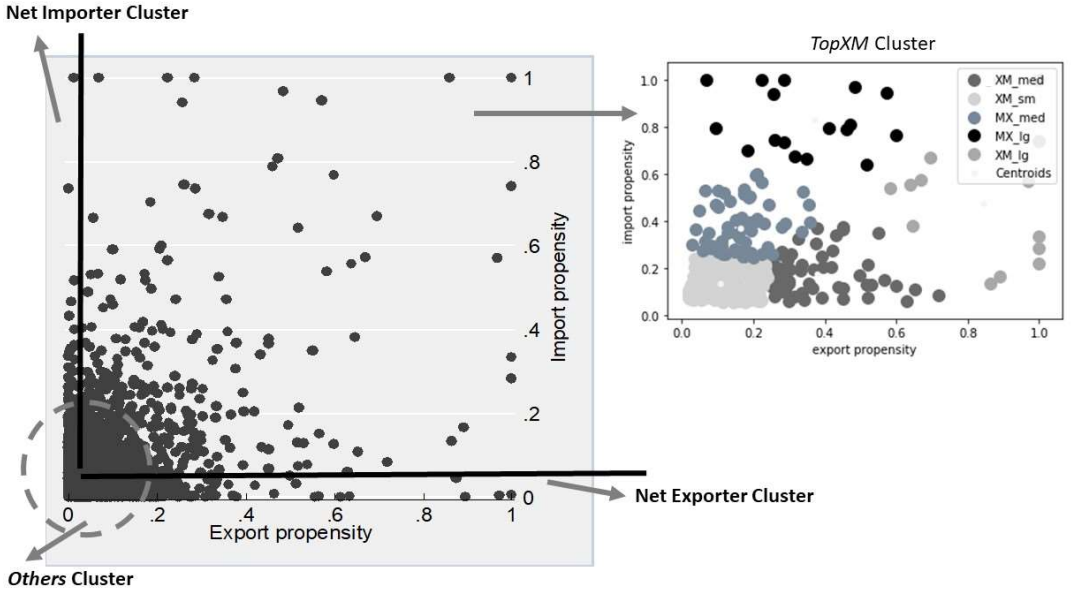
Machine learning techniques were employed to further cluster firms in the *Top XM* and *others*, per age category. The clustering algorithm, *K-means*, identifies and groups together the segments of the data

[9] Normalization is done by dividing the difference between the total export transactions (sumtrans) of a firm, *i,* in time *t,* and the smallest number of transactions recorded for all firms in time *t,* with the difference between the maximum and minimum number of export transactions reported for all firms in time *t*, that is,
$Exporttrans_{it} = (sumtrans_{it} - \min(sumtrans_t)/[\max(sumtrans_t) - \min(sumtrans_t)]$

[10] Age groups consist of : 1-3, 4-6, 7-9, 10-12, 13-15, 16-18, 19-20, 21 years.

based on the export and import propensities.[11] Figure 3 provides an overview of the groups produced by the selection process thus far. Net exporters and importers total to 1,009 firms and account for 8% of total export revenues, while firms with the highest propensity to both import and export total to only 391 firms but contribute 53% of total export sales. Five clusters resulted from these latter firms, with most of revenues being earned in clusters 3 (intermediate levels of import and export propensities; with greater propensity to import relative to export or *MX_med*), 4 (high exports and import propensities; with greater propensity to import relative to export or *MX_large*) and 5 (high exports and import propensities; with greater propensity to export relative to import or *XM_large*). The 93 firms in these clusters account for 42% of all exports earned by all exporting firms from 1991-2012.

Figure 3 Philippine Exporting Firm Clusters



Notes: The two figures are not perfectly congruent. This is because the *TopXM* cluster is generated by the outlier selection that breaks down the observations into age categories, and selects the firms with the highest export and import propensities per category.

The final selection stage involved an analysis of firm demographics, where the entry, re-entry, continuous exporting, permanent exit and one-time entry of each firm is traced. We can assume that the affiliates of Multinational Firms in global production networks will tend to export extensively upon establishment. We were therefore particularly interested in firms that display such a global export orientation immediately upon first entry. Each year, firms that are classified as *global* are those that simultaneously export to all major markets, namely, US and Japan, and at least a country in each of the

[11] We implement the K-means algorithm through Python which addresses the random initialization trap, and generates reproducible and consistent results. The *Elbow Method* is used to identify the optimal number of clusters.

country groups of EU-12[14], ASEAN[15], East Asia (i.e. Taiwan, Hong Kong, South Korea, China), and the Rest-of-the-world. Focus was given to the incidence of new entry among these global firms.

Among the firms that were eventually selected as being most likely to be in global production networks, a distinction was made between those selected from *Top XM* and *Others,* named *GPN1* and *GPN2,* respectively. *GPN1* firms were selected from those in clusters 3 (*MX_med*), 4 (*MX_large*) and 5 (*XM_large*), as well as those that are global when they first enter and continued to export till 2012. This would be considered as the category of firms most likely to be integrated in global production networks. To avoid committing a false negative or a *type II* error, we created another group, *GPN2*, whose firms display the characteristics of high overlapping exporting and importing intensities, as well as rapid attainment of a global exporting status. Thus, for *GPN2,* we included the firms in *Top XM* not selected in *GPN1* plus the global firms in *Others* that attained this status in 4 years (average of all global firms) or quicker. The firm category *Others* is recomposed from the rest of unselected firms, but excluding firms that export sporadically.

In total, this exercise resulted in 6 basic firm categories: *GPN1* (327 firms); *GPN2* (422); *Net Exporters* (331); *Net Importers* (313); *Sporadic* (1,022); and *Others* (2,052).

3.2 *Methodology for tracking the position of PH firms in Global Production Networks*

The rich longitudinal data at our disposal allowed us to identify the export and import nodes that form the rings in the production network of local and foreign firms. The stumbling block in understanding how the division of labour among international firms evolves in vertically integrated sectors is the inability to determine which imported goods enter as inputs in which export product. In contrast, the data used here, with the highest level of disaggregation, allowed us to extract an indicator of GPN linkages. The production and sourcing behaviour of each firm in our data provided us some gauge of how Philippine firms are integrated in a global value chain, by enabling us to match export products with their import baskets or composites.

Export products are grouped into 15 sectors: (1) Food & Animals / Beverages & Tobacco / Crude Materials; (2) Minerals Fuels, Lubricants, Related Mtls. /Animal & Vegetable Oils, Fats & Waxes; (3) Chemicals; (4) Manufactured goods classified chiefly by material; (5) Travel Goods, Handbags, Apparel & Clothing, Footwear; (6) Furniture; (7) Photographic apparatus, equipment and supplies and optical goods, watches and clocks; (8) Other Miscellaneous Manufactured Articles; (9) Handicrafts; (10) Footwear, Garments (materials on consignment basis); (11) Machinery, Office Machines; (12)

[14] EU12 refers to the composition of the European Union as per January 1986: Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, and the United Kingdom.
[15] ASEAN countries consists of Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Thailand, Singapore and Vietnam.

Electronics; (13) Semiconductor devices ; (14) Road Vehicles; and (15) Samples/Others.[16] This product classification was made in order to better highlight the sectors typically associated with global production networks (e.g. garments, electronics, semiconductors, road vehicles). We then compared the mean unit values of each firm's exports by sector by year, with the mean unit values of the firm's imports by partner. Only products with revenue shares greater than ten percent of the total annual import expenditures of each firm are considered. In this way, the dynamics of Philippine participation in GPNs could be observed by comparing the mean unit values of Philippine exports with the mean unit values of the exports of its partners to the country's firms. One would expect that countries that export high-value goods specialize on capital and skill-intensive activities, while those in the lower price spectrum are instead focused on labour-intensive production segments. The persistent variations in export prices across country suppliers within narrow product categories would also suggest intrinsic differences in product quality. In a GPN context, we can thus take these differences as an indicator of the division of labour among firms that also signals in which production segment each affiliate specializes in. Of course, since the performance of the other partner economies in the chain is seen only from the perspective of the Philippines, it remains impossible to determine their own true respective position with respect to the GPN as a whole. Nonetheless, it provided a useful snapshot of how a GPN might be organized by their foreign lead firms.

3.3 *Upgrading of exporting firms*

The next step was an analysis of whether upgrading, in the form of a shift to higher quality varieties and/or increase in process efficiency, has taken place. We adopted the Kaplinky-Readman (2005) framework, where *product quality upgrading* is signalled by higher unit values accompanied by greater demand, as indicated by an increase in sales volume. Higher export revenues accompanied by falling unit values, on the other hand, result from a significant boost in demand and would thus be indicative of improvements in productivity or upgrading in *process efficiency*.

In order to gauge the additional random effects introduced by firms being grouped along employment size, ownership, sectors and firm types, we employed a firm fixed-effects panel logistic regression model combined with a mixed effects logistic regression. The effects of these time-constant variables are often estimated using the Random Fixed Effects models despite evidence of strong correlation between the individual fixed effects and the included regressors. In such event, the panel-level variance is actually unimportant and the panel estimator will not be significantly different from a pooled estimator. On the other hand, ignoring the contribution of important variables such as size and ownership to the heterogeneity of upgrading probabilities is likewise problematic, especially in our

[16] See Appendix Table 1A for details.

context where we would like to understand the differences of upgrading behaviour between GPN and non-GPN firms, or between fully-Filipino owned firms and those with Japanese majority ownership, for instance.

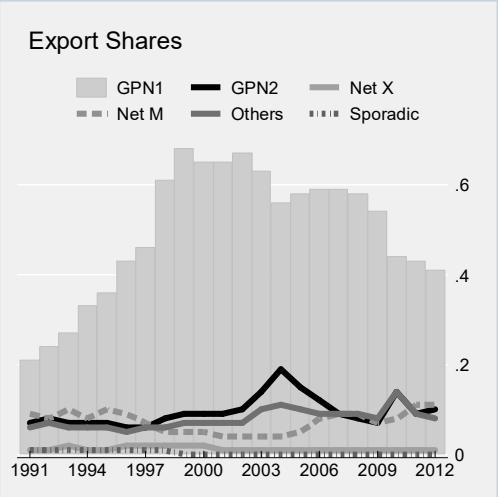
We therefore opted for the more appropriate model of firm fixed effects, but likewise utilized a mixed effects model, which can capture the random effects of being in different size, ownership, or sectoral categories. To 'rank' the importance of these categories, so-called Empirical Bayes estimators were derived which capture the different additional effects introduced by each subset categories relative to the average random effects of the group under study. In addition, these estimators address the problem of comparing groups with large differences in occurrences, so that one can more accurately estimate and compare the propensity to upgrade between, say, Filipino-owned firms with thousands of export spells and Swedish-owned firms with less than ten export transactions.

For the fixed-effects logistic regression model we investigated the influence on upgrading of selected variables, such as degree of competition (proxied by Grubel-Lloyd index), product differentiation (proxied by number of subsectors per product group), lagged exchange rates (i.e. growth in real effective exchange rates, expressed as US$/Pesos PH), and the incidence of product upgrading in imports which can proxy for the influence of access to higher quality inputs or technology.

4. Results 1: differences due to Global Production Network integration

The new firm typologies provide a glimpse of the enormity of the heterogeneity among firms which is often collapsed into the black box of the fixed-effects estimators of standard econometric models. Much attention in the literature is given to understanding the wide differences between exporting and non-exporting firms, but much less is lent on unveiling the distinctions found within the pool of exporters themselves. While it is true that the differences between exporting and non-exporting firms are so huge that only very few firms manage to enter and survive in foreign markets, the variation among exporters reveal a highly dualistic structure, separating firms that produce world quality and high-technology products operating within the super highways of global production networks, and those that remain within the comforts of the country's comparative advantage relying mainly on self-built trading networks.

Figure 4 Export Shares of Firm Clusters in Total Export Revenues, 1991 - 2012



The 327 (out of 5,877 manufacturing) firms selected as *GPN1* tower over the rest of the firm population of the Philippines. While they are initially filtered as being outliers in terms of the export and import transaction intensities, they are clearly outliers in many other aspects as well. As shown in Figure 4 and Tables 2 & 3, *GPN1* firms are decisively bigger (in revenues and employment size), produce and source higher quality and a greater number of exports and imports, respectively, earn relatively bigger trade surpluses, export and import to and from more markets, and are mostly foreign-owned. The more that we zoom in on the biggest 30 firms in the group, which together account for almost a third of all export revenues in the 22 years of the data, the sharper these differences become relative to other firms.[17]

Given the strict confidentiality of the data, the names of the firms are unknown and could therefore not be used to verify whether these are affiliates of multinational firms. Information on ownership and size as shown in Table 2, however, reveal distinct patterns that could point to the firm cluster that is most likely to contain this type of firms. *GPN1* firms, for instance, with the highest number of foreign-owned and large firms seemed to be populated by MNC affiliates, while *GPN2* firms are also globally-oriented in their exports, but with more local and small- and medium-sized firms.[18]

[17] See Table 2A in the Appendix.

[18] Only 52 of *GPN1* firms are located in *EPZ,* but all *are* globally oriented. Location and/or market orientation are insufficient to filter out firms that are heavily engaged in GPNs. Export processing zones host diverse types of firms (i.e. includes sporadic firms), while globally-oriented firms include outlier firms which either export but rely heavily on domestic inputs, or import but sell their output largely to the domestic market.

Table 1 Characteristics of Firm Types

	Median	*EPZ*	*GPN1*	*GPN2*	*net Imp.*	*net Exp.*	*Others*	*Sporadic*
Number of Firms		1023	327	422	313	331	2,052	1,022
Share in Total Export Rev.		44%	52%	10%	7%	1%	8%	0%
Export Values (US$ M)/firm	2.2	11.2	174	36	0.3	9.9	1.8	0.06
Import Values (US$ M)/firm	4.4	12.1	111	16	32	0.2	5.2	0.6
Trade balance/firm (US$ M)	0.01	0.7	39	15	-31	9.3	-0.2	-0.2
Export Unit Values (median)	12	26	41	20	19	8.2	11.5	7
Import Unit Values (median)	22	45	87	30	46	13	22	14
Number of Export products	17	29	80	41	11	44	16	4
Number of Import products	60	107	333	123	231	12	69	19
Number of Export destinations	8	13	39	24	7	27	8	2
Number of Import sources	11	12	26	14	23	5	11	6
Export Transactions/year	6	5	43	22	1	15	6	1
Import Transactions/year	14	17	117	35	29	2	16	4

Source: Authors own computation, data from the Philippine Statistical Authority.

Table 2 Ownership & Size* Structure

	PH	**JPN**	**US**	**EU12**	**Small**	**Medium**	**Large**
GPN1	33%	33%	5%	8%	15%	16%	68%
GPN2	55%	20%	2%	4%	32%	18%	47%
NetX	85%	2%	2%	3%	68%	14%	15%
NetM	61%	15%	5%	6%	31%	19%	48%
Others	68%	13%	1%	2%	57%	17%	20%
Sporadic	82%	3%	1%	2%	70%	13%	9%

Notes: * Small (10-99); Medium (100-199); Large (200 – 2000 & over), based on PSA classification.
Source: Authors own computation, data from the Philippine Statistical Authority.

Interestingly, the firm selection process based purely on export and import transaction intensities produced clusters with distinct sectoral orientation as well. As Table 3 shows, *GPN1* firms, being largely owned by foreign firms from capital and technology-rich countries, operate mainly in sectors such as *Transport & Machinery Equipment, Electronics,* and *Semiconductors*, or sectors 11, 12 & 13, respectively. Since 2000, exports have diversified away from *Semiconductors,* which at its peak in 1995 represented two thirds of all revenues earned. It is interesting that while large net exporters are further specializing in agricultural and resource-based products, the opposite trend is taking place for firms in *GPN2* and in the largest categories of *Others* and *Sporadic.* The shift towards semiconductor exports is particularly extreme for *GPN2* firms, which in 2010 earned more than 80% of their export revenues from these manufactures. This change of course was most evident in 2003, when the share of this sector rose rapidly to 62%, almost double from just the previous year. A sort of local *flying-geese*

phenomenon seems to take place as the largely foreign-owned firms (*GPN1*) in the semiconductors sector move out of segments where technological change has increasingly standardized production, and more local firms step in to fill in the niche. Although, a closer look at these late-comer semiconductor firms would show that half are Japanese-owned and only a quarter are fully locally-owned firms. More than half of all export transactions were contributed by large firms with more than 2000 employees. Clearly, these firms are outliers in their category, also in terms of demographics, as will be shown later.

Table 3 Comparison of relative importance of sectors for various firm types, 1995 & 2010

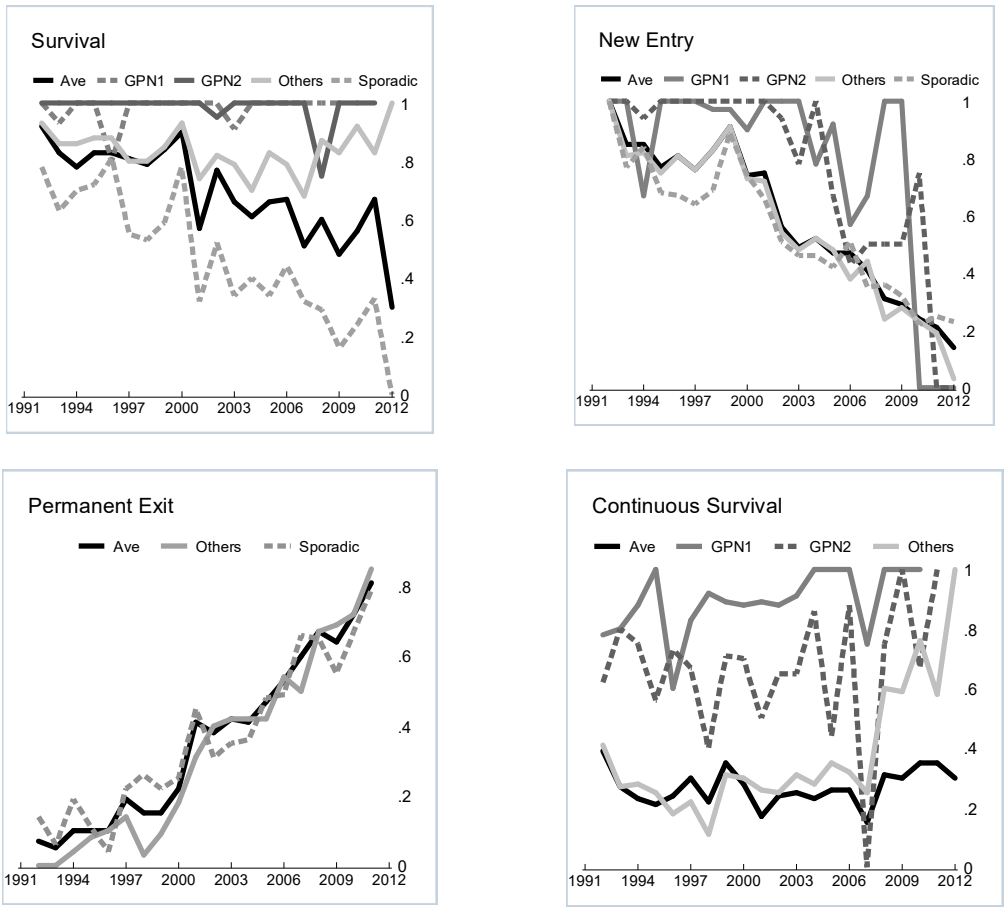
sector	GPN1		GPN2		Net X		Net M		Others		Sporadic	
	1995	2010	1995	2010	1995	2010	1995	2010	1995	2010	1995	2010
1	0.03	0.02	0.07	0.03	0.31	0.35	0.01	0.03	0.15	0.10	0.22	0.14
2	0.02	0.01	0.07	0.09	0.00	0.16	0.09	0.12	0.12	0.07	0.43	0.26
3	0.01	0.02	0.03	0.01	0.00	0.03	0.07	0.18	0.03	0.02	0.02	0.04
4	0.01	0.03	0.06	0.03	0.15	0.19	0.25	0.48	0.07	0.10	0.17	0.25
5	0.03	0.02	0.18	0.01	0.06	0.04	0.02	0.00	0.19	0.10	0.03	0.03
6	0.01	0.00	0.14	0.00	0.26	0.06	0.00	0.00	0.03	0.02	0.03	0.07
7	0.01	0.01	0.00	0.01	0.00	0.02	0.00	0.00	0.00	0.01	0.00	0.02
8	0.01	0.00	0.05	0.01	0.11	0.04	0.01	0.00	0.05	0.06	0.04	0.11
9	0.00	0.00	0.00	0.00	0.11	0.06	0.00	0.00	0.01	0.01	0.01	0.01
10	0.04	0.01	0.28	0.01	0.01	0.00	0.05	0.00	0.21	0.04	0.02	0.02
11	0.03	0.19	0.01	0.03	0.00	0.00	0.01	0.05	0.02	0.06	0.00	0.02
12	0.22	0.27	0.07	0.01	0.00	0.02	0.41	0.06	0.05	0.13	0.00	0.02
13	0.57	0.33	0.00	0.83			0.00	0.00	0.00	0.46	0.00	
14	0.01	0.06	0.01	0.01	0.00	0.01	0.02	0.06	0.01	0.06	0.02	0.01
15	0.01	0.02	0.01	0.00	0.00	0.00	0.07	0.02	0.05	0.10	0.00	0.01

Source: Authors own computation, data from the Philippine Statistical Authority

The differences between *GPN* and other firm types become even more pronounced in Figure 5 where we look at the firm demographics, or the birth, death and re-entry of firms in the export market.[20] *GPN* firms in general, have almost 100% survival rates (i.e., new entrant's survival in the following year), while less than half of *Sporadic* firms survive the next year after first entry. In fact, almost all of the 436 firms that export for only one year, the so-called *one-timers* are found in this firm category.

[20] Appendix Table 1A reports the average number of entry, exit, survival, new-entry, re-entry, one-time entrants (i.e. new entrants that permanently exit the following year), resilient firms (i.e. new entrants without any exit spells till the end of the data), and permanent exiters for all firm types.

Figure 5 Rates of Survival, New Entry, Permanent Exit & Continuous Survival, across firm types, 1991-2012



Notes: New Entrants are firms that never appeared in years before entry; new entry rates are the share of new entrants in total entrants. Survival rates is the percentage of new entrants surviving in the succeeding year. Permanent exit rates are the share of permanent exiters in total exiters. Resiliency rates is the share of resilient or continuing exporters (i.e. no exit spells from year of entry) in total new entrants.

Source: Author's calculation based on PSA Trade database

Firms that have managed to attain a global reach in exports upon entry is of particular interest. One would expect that exporting globally immediately upon first entry is not something an average firm would be able to achieve. Conversely, firms that manage to do so are most likely linked to multinational firms with established networks worldwide. Indeed, as Table 4 would show, while only 224 firms out of a total 1,538 of global firms were able to attain the feat of being global on the year of first entry, close to half of the *GPN1* firms that exported globally did so on their first exporting year. In contrast, only around 8 percent of non-GPN firms managed to be global exporters upon initial entry.

Table 4 Profile of Global Firms

	Total Global firms	Global New Entrants*	Years to become global	Dominant Ownership	Employment Size**
GPN1	293	120	1.8	Japanese	9
GPN2	394	44	2.4	Filipino	5-7
Net X	216	53	2.7	Filipino	4
Net M	113	7	6	Filipino	3
Others	448	0	8	Filipino	3
Sporadic	74	0	7	Filipino	3

Notes: * New Entrants are firms that did not appear in any previous years as well as firms that were already present in 1991.
** Size classification based on PSA: 0 (1-4); 1 (5-9); 2 (10-19); 3 (20-49); 4 (50-99); 5 (100-199); 6 (200-499); 7 (500-999); 8 (1000-1999); 9 (2000 - over).
Source: Authors own computation, data from the Philippine Statistical Authority

Falling rates of new entry, however, is a shared pattern among all firms. In the 1990s, more than 90% of entering *GPN* firms are new entrants, while from 2003 onwards, this has dropped to just 60% and 40% for *GPN1* and *GPN2* firms, respectively. Two thirds of all permanent exits in this group also occurred during the same period. Permanent exit among *GPN* firms have been rare, but the effect of the financial crisis of 2007-2009 is palpable, with more than half of permanent exits occurring in this period, and only 25 new firms being added into this group. The ability of firms to export globally has particularly weakened especially in the latter part of the 2000s.

One way to explain the sluggish performance of overall Philippine exports is to point at the falling entry of new firms and the drop in survival rates of those who managed to enter, on one hand, and the rising incidence of permanent exit from export markets, on the other. Interestingly enough, while some notable exits among the top exporters has taken place since 2004, in general, they appear to have little difficulty in continuing to export. It is mostly in the firm categories populated by small, Filipino-owned firms where the struggle to re-enter and survive the competition in global markets is most found. As table 4 shows, non-GPN firms (constituting 87% of total) are mostly Filipino-owned firms exporting agriculture-based goods and labour-intensive manufactures such as clothing, footwear, furniture and handicrafts.

5 Results 2: Position and upgrading of Philippine firms in Global Production Networks

The production and sourcing behaviour of each firm in our data provides us with an indicator of how Philippine firms are integrated in a global value chain, by enabling us to match export products with their import baskets or composites. The dynamics of Philippine participation in GPNs could thus be observed, using the trends in unit values as a guide in tracing the position of the country in a GPN's specialization ladder.

Table 5 Global Production Network in Semiconductors, illustrated through combined unit values of exports and unit values of imports of Philippine firms

Product	Country	Country share in total import expenditures of GPN1 Semicon. Exporting firms	Ave unit value (US$)
Dice (9310111)	US	52%	6,925
For the manufacture of electrical and electronic machinery, equipment and parts (9310191)	Japan	48%	834
Wafers and discs, electrically circuit-programmed, whether or not coated on one side with gold or aluminium (7764300)	Taiwan	18%	1,047
Other Cards incorporating "smart" cards (IC) (7649109)	South Korea	43%	849
Other Cards incorporating "smart" cards (IC) (7649109)	Malaysia	14%	752
Oth mat'l & accesrs, consign basis for manuf of semi-conductor devices (9310119)	China	10%	418
Semiconductors (9310221)	*Philippines*		523

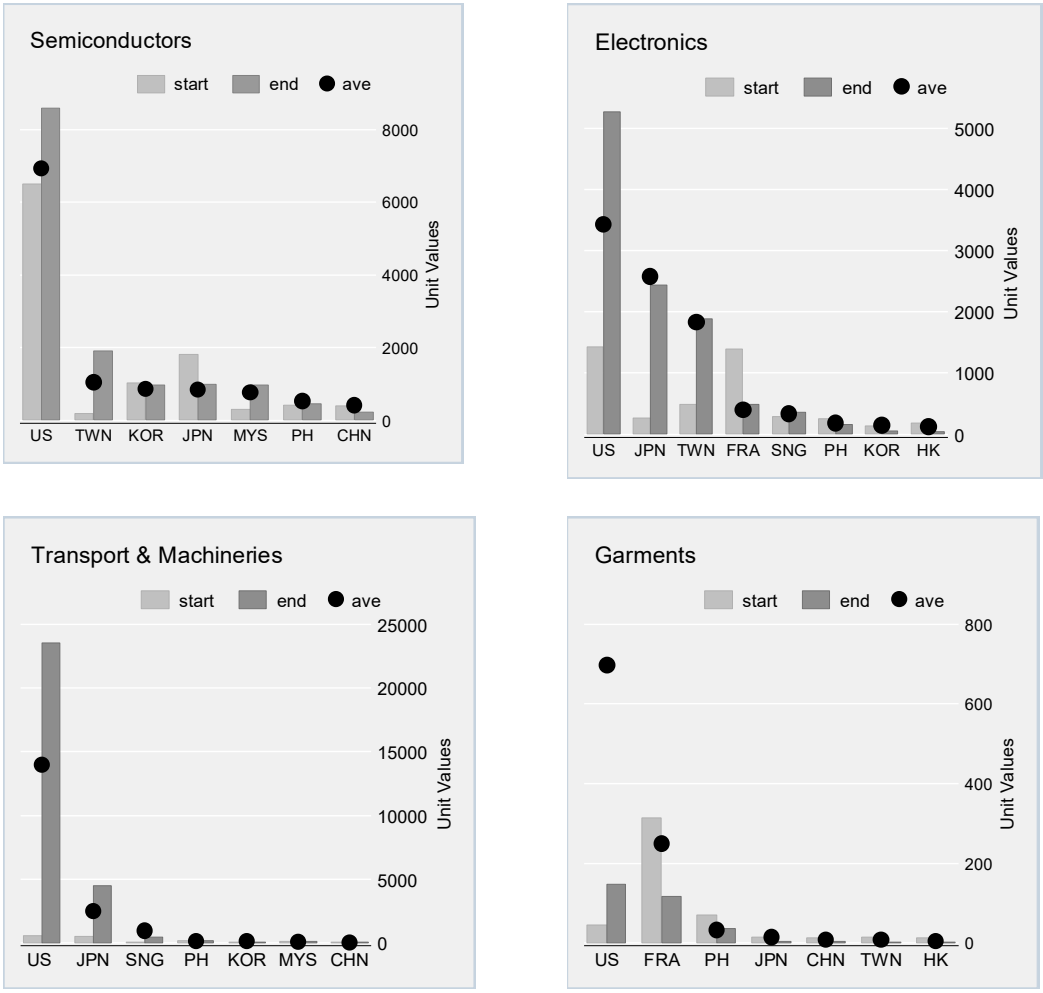
As an illustration, Table 5 reports the top imports of the *GPN1* firms that primarily exports semiconductors, the sector that accounts for 52% of all export revenues earned by *GPN1* firms.[21] By comparing the mean unit values of the imports from the top supplier countries with the mean unit values of the exports of semiconductors by the *GPN1* firms, we roughly assemble a quality ladder depicting the position of countries involved in the manufacture of the said product. Figure 6 exemplifies the application of this approach to four key sectors.

There are four characteristics of production networks of the GPN firms that are worth noting here. First, import transactions are more concentrated than those linked to exports. While over 80 percent of all import transactions are conducted with only six countries (i.e., Japan, USA, South Korea, Malaysia, Singapore and Taiwan), the same percentage of export transactions were spread to more than thirty countries. Second, as one would expect, high-income partners specialize in technology-intensive inputs while Philippine firms largely contribute labour-intensive activities, such as the testing, assembly and packaging of semiconductors. Third, the triangular pattern of trade is quite evident in the manner in which inputs were sourced heavily from the US and Japan, and sold mainly to the Asian regional market for further processing. Fourth, the distinct dissimilarity between the nature and direction of exports and imports indicate the fine division of labour among participants in the GPN. In fact, the type of

[21] These imported inputs represent at least 10% of the total import bill of the said firms.

semiconductor devices produced by the Philippines (PSCC 9310221) has never been imported by any firm at any point in time, while top imports have likewise never been exported by any local firm.[22]

Figure 6 Quality ladder in Semiconductors, Electronics, Garments and Transport & Machineries sectors (by *GPN1* firms), based on unit values in (constant) US$



Notes: The initial (start) and last (end) unit values are reported and compared to the average of each partner country from 1991-2012. Semiconductors aggregates 24 PSCC 7-digit production lines (sector 13); 328 for Electronics (sector 12); 530 for Transport & Machineries (sector 11); and 14 for Garments (sector 10). See Table 1 for details. CHN (China); FRA (France); HK (Hong Kong); JPN (Japan); KOR (South Korea); MYS (Malaysia); SNG (Singapore); TWN (Taiwan); and US (United States).

No marked changes over time are evident as far as the position of Philippine firms in the production networks featured here is concerned. Differences in average unit values between Philippine and partner producers are consistent with the pattern of specialization where the Philippines demonstrates a

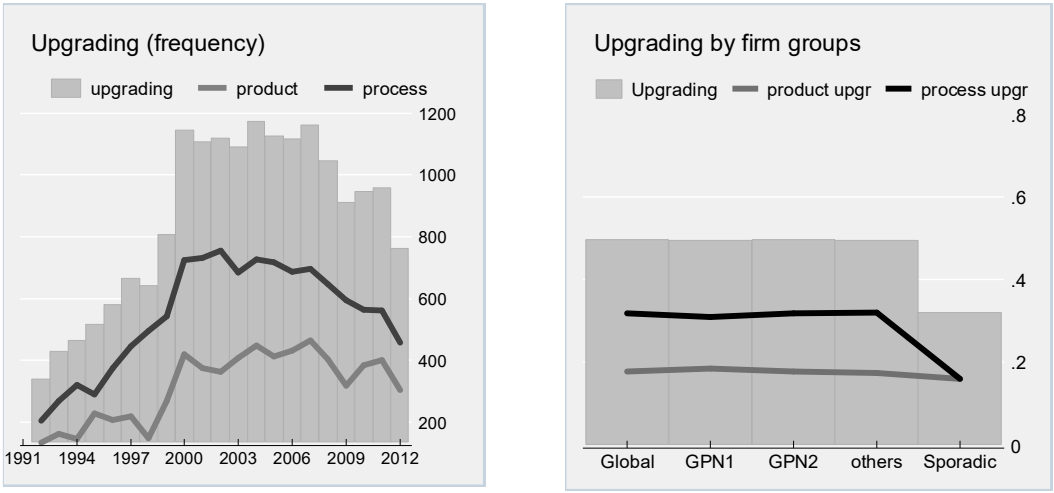
[22] With the exception of one product, optical measuring and checking instrument (PSCC 8742503), which has been exported only once and by just a single firm.

comparative advantage in labour-intensive and thus lower value export goods, and a comparative disadvantage in higher value capital-intensive imports. In sectors characterized by scale economies, high fixed costs and thus high entry barriers, GPN firms fare well in terms of high unit prices for their exports, relative to countries with more similar endowments, such as Malaysia and China. It is in labour intensive sectors such as furniture, textile and garments, where the patterns of low value exports can be found.

6. Discussion: Product Quality upgrading of Philippine GPN exporters

There is a widespread notion that developing country firms in GPNs have been stagnating at the lowest value-segment of the production process. We therefore scrutinize whether upgrading, in the form of a shift to higher quality varieties and/or increase in process efficiency, has taken place. As in Kaplinsky & Readman (2005), we consider the simultaneous occurrence of higher unit values and greater demand as signalled by an increase in sales volume as an indication of product quality upgrading. Higher export revenues accompanied by falling unit values, on the other hand, result from a significant boost in demand and would thus be indicative of improvements in productivity or upgrading in process efficiency. The general trend of falling unit values of both exports and imports across sectors, in fact, reflect the great strides in productivity, which the manufacturing sector has attained in the last two decades. The patterns of upgrading across firm sets throughout the period of 1991-2012 are depicted in Figure 7.

Figure 7 Upgrading Trends across Firm Types in the Philippines, 1991-2012



Source: Authors own computation, data from the Philippine Statistical Authority.

Upgrading comes largely in the form of process upgrading, but the frequency of which has fallen from 31 percent of total observations in 1992 to 24 percent in 2012. Upgrading has a low coefficient of

variation of just 1.02, most of it originating from within-firm variation rather than between firms. For product upgrading, in fact, most of the variation is generated by within-firm observations, suggesting that while firms tend to discriminate prices across destinations, firms display relatively similar patterns of upgrading regardless of their types. Transition probabilities also indicate that product upgrading is relatively seldom, occurring only 17.5 percent of the time, and with the likelihood of upgrading in the next period even slightly lower at 17 percent.

The aftermath of the Asian crisis, the dot-com bubble and the financial crisis also seem to be palpable in the propensity of firms to upgrade. The dips in upgrading rates occurred in 1998, 2001 and 2009, at 50 percent, 47 percent and 38 percent, respectively. The differences in upgrading across firm types are marginal, but *sporadic* firms clearly show a lower propensity to upgrade (32%) relative to the rest of the firm set.

We further investigated the determinants of upgrading over time using a fixed-effects panel logistic regression model and a mixed-effects logit model to determine the random effects of belonging in various firm, size, ownership and sectoral categories. The odds of product upgrading are estimated based on the several predictor variables such as *GLI*, which is the Grubel-Lloyd index measuring intra-industry trade for industry *j*, time *t* and a proxy for degree of sectoral competition. The expectation is that more upgrading can be a response to greater competition from imports as indicated by more overlap with imports. Product differentiation is proxied here by *QL* which stands for quality ladder or the number of sub-sectors per product group. The effect of access to higher quality inputs or technology, as proxied by the incidence of product upgrading of imports is also inspected. Finally, the role of (lagged) exchange rates is estimated by the coefficient of *XCHNG* which is the growth in real effective exchange rates (expressed as US$/Pesos PH).

Table 6 summarizes the results with column 1 estimated by a panel logit model with both firm and time fixed effects, but excluding the exchange rate variable, while column 2 introduces this variable but drops the time fixed effects. Only exchange rates perform consistently in the fixed-effects logit model, with an exchange rate appreciation leading to slightly higher likelihood of upgrading. This implies that firms are prompted to improve the quality of their products so as to maintain their market shares despite the strong peso. Increased acquisition of higher valued imported inputs also brings about higher upgrading probabilities. A one percent increase in the incidence of import upgrading leads to around 5 percent more product upgrading.

Table 6 Logistic Regressions

Odds-Ratio	product upgrading (1)	product upgrading (2)	product upgrading (Ownership) (3)	product upgrading (Size) (4)	product upgrading (Sectors) (5)	product upgrading (firm type) (6)
GLI	1.12**	1.12**	0.99	1.003	1.025	1.025
QL	1 (omit)	1 (omit)	1(omit)	0.99	0.99*	0.99**
UpgrM	1.03	1.04**	1.05***	1.047***	1.05***	1.05*
XCHNG (t-1)		1.01***	1.01***	1.01***	1.01***	1.001***
AgeX			0.99***	0.993***	0.99***	0.99***
Firm Effects	*yes*	*yes*				
Time Effects	*yes*	*no*				
Mixed Effects			*yes*	*yes*	*yes*	
Observations	103,690	103,690	173,553	173,553	173,553	173,553
Firms	3.351	3.351	3,351	3,351	3,351	3,351

Notes: Fixed Effects Logistic regression. Dependent variable: product upgrading (prd_up =1, if quantity and value changes are both positive). The explanatory variables include *GLI (Grubel-Lloyd intra industry Index)*; *QL,* quality ladder (product differentiation) *UpgrM* (positive change in import unit values), lagged *XCHNG* (change in real effective exchange rates). Columns 1-2 estimated by panel logit model and columns 3-6, by a mixed-effects logistic regression.

***p <0.01; **p <0.05; *p <0.10

Columns 3 – 6 in Table 6 reports the results generated by a mixed-effects panel logit, where the log odds of upgrading are modelled as a linear combination of the explanatory variables allowing for the presence of both fixed and random effects. The purpose is to ascertain whether or not variations in being in a particular size, ownership, sectoral or firm category affect the firm's propensity to upgrade the quality of its exports. This can be seen in the values of *sd_cons* as reported in Table 6a. The standard deviation of 0.026 indicates that firms in an ownership category which is one standard deviation above the mean have odds of upgrading that are 2.6% higher than comparable firms in an average ownership type [exp(0.026) = 1.026]. To identify the ownership structure where firms would be more or less likely to upgrade, we compute so-called Empirical Bayes estimators[24], which ranks the components of the ownership set based on upgrading probabilities.

Firms that are Japanese-owned, with a thousand or more employees, active in the Semiconductor sector and classified as being in the *GPN1* firm type display the greatest propensity to upgrade. Instead, the probability to upgrade is lowest among Philippine-owned firms, with around 5 – 99 employee size, and exporting agriculture-based and traditional products such as handicrafts, and belonging to the firm set of net exporters (*Net X*) and sporadic firms categories.

[24] See Rabe-Hesketh & Skrondal (2008, p. 265) for more on Empirical Bayes Estimation.

Table 6a Empirical Bayes Estimators

OWN	**product upgrading** ***(3a)***	**Employment SIZE**	**product upgrading** ***(4a)***	**SECTOR**	**product upgrading** ***(5a)***	**FIRM TYPES**	**product upgrading** ***(6a)***
sd(_cons)	0.026	*sd (_cons)*	0.0492	*sd (_cons)*	0.05	*sd (_cons)*	0.03
PH	-0.016	0 (1-4)	0.012	Agri	-0.075	GPN1	0.045
JPN	0.03	1 (5-9)	-0.036	Minerals/Fuel	0.008	GPN2	0.000
US	-0.01	2 (10-19)	-0.065	Chemicals	0.005	Net Xters	-0.055
EU12	0.012	3 (20-49)	-0.153	Raw Mtls	0.008	Net Mters	0.022
EA	0.013	4 (50-99)	-0.069	Garments/Foot	0.033	Others	-0.008
ROW	-0.031	5 (100-199)	0.026	Furniture	0.006	Sporadic	-0.044
		6 (200-499)	0.02	Appatus/Mch	0.041		
		7 (500-999)	0.025	Misc MFG	-0.013		
		8 (1000-1999)	0.05	Handicrafts	-0.088		
		9 (2000 – over)	0.052	Garments (con)	0.018		
				Transp & Mch	-0.025		
				Electronics	0.007		
				Semiconductor	0.097		
				Road Vehicle	-0.001		

7 Conclusion

This paper considered the value ('net worth') for national development of being engaged in global Production networks. To add to the extant research, we developed a novel longitudinal data set for one country at the level of firms. The most critical task in this process was to identify the firms that are most likely to be heavily integrated in these networks so as to be able to assess their performance not only vis-à-vis the rest of the local firm population but also relative to the other foreign firms engaged in the same international supply chains. Utilizing the new Philippines trade transactions data encompassing over two decades, from 1991-2012, we also developed a novel firm selection methodology that exploits the pattern of exporting and importing propensities of each firm. This approach combines outlier selection, *K-means* clustering algorithm, firm demographics, and market orientation analyses. *GPN*-integrated firms are therefore those that: (1) display the highest dependence on foreign markets both for export sales and source of inputs, that is, they are in the top quintile of exporting and importing propensities; (2) have highest survival rates given that they operate on 'organized' markets; and (3) attain a global export coverage at the shortest amount of time.

The clustered-firm analysis unravels the extent of heterogeneity among firms in a different manner than extant macro-economic research. Our results showed that GPN firms are indeed distinctly different from traditional exporting firms. They are significantly bigger, both in terms of employment size and revenues; produce and source higher quality and a greater number of exports and imports, respectively; earn relatively larger trade surpluses; export and import to and from more markets; and are largely foreign-owned. Half the number of these firms have also attained a global export coverage (i.e., simultaneously exporting to US, Japan and at least one country in EU12, East Asia, ASEAN, and Rest-

of-the-World), in their first exporting year, compared to the set of non-GPN firms, where only 8 percent managed to attain a similar feat.

An interesting finding has been that the firm selection process, while being based purely on export and import transaction intensities, likewise produced clusters with distinct patterns of sectoral orientation. As to be expected, the top GPN-firms are largely specialized on sectors characterized by high degree of production fragmentation, such as electronics, semiconductors and machinery equipment. However, while most of these firms have diversified away from Semiconductors exports, the populous set of largely local firms have instead moved towards this sector, with the shift being particularly extreme for the firm cluster that have a lower level of resilience, lower trading propensities relative to GPN-firms but also consists of firms with global export orientation (i.e. *GPN2* firms). We observe a local *flying-geese* phenomenon taking place as the largely foreign-owned GPN firms in the semiconductors sector move out of segments where technological change has increasingly standardized production, and more 'local firms' step in to fill in the niche. Half of these late-comer exporters, however, are Japanese-owned firms: they have greater access to key technologies and the longer term effects on relevant upgrading for the local economy might be strongly mitigated by their (network) strategies, which are however strongly related to the strategies of Japanese lead firms.

Several distinct features of global production networks for a lower-middle income country (imbedded in a regional division of labor as created by ASEAN) could also be established. These networks are characterized by a high concentration of import sourcing, combined (and related) with a more diversified pattern in exporting. This is consistent with the triangular trade pattern where inputs are sourced within the network, and then exported to the rest of the world. As expected, high unit values of products exported by developed economy partners indicates a specialization on technology-intensive goods. Finally, there is an extremely fine division of labour within a GPN, where hardly any overlap of exported and imported goods (at the highest level of disaggregation) can be detected.

One would expect that rapid technological change would induce continuous upgrading, especially among the more technology-driven country partners in the network, thereby presenting a clear opportunity for middle income countries firms in the chain to climb-up the quality ladder of manufacturing. At first glance, the fact that no marked changes were evident in the position of Philippine firms in the selected production networks studied here could lend support to the popular view that developing country firms find it difficult to escape the lowest value-added segment of production. However, GPN firms have been observed to be diversifying away from Semiconductors, for instance. Further research could attempt to verify whether or not these export shifts represent a form of upgrading by developing approaches to examine product quality trends across different sectors and firm clusters through time.

Our results also confirm the widely-held perception of weak upgrading among firms, with the incidence of product and process upgrading being only around 17.5 and 32 percent, respectively. Zooming in on the determinants of product upgrading using a fixed-effects panel logistic regression model and a mixed-effects logit model, we find that firms that utilize higher quality imported inputs upgrade more. The nesting of firms in distinct categories of employment size, ownership, sector, and clusters created by our firm selection approach, also generate differences in upgrading behaviour. Firms that are Japanese-owned, with a thousand or more employees, active in the Semiconductor sector and classified as being in the *GPN1* firm type display the greatest propensity to upgrade. Locally-owned firms, in the 5 – 99 employment size range, exporting agriculture-based and traditional products, and clustered in the net exporters (*Net X*) and sporadic firms categories, instead upgraded the least. Essentially, however, it the mean trend that mostly prevailed among firms, and upgrading was largely influenced by macroeconomic variables such as exchange rates. This suggests that bottlenecks external to the firm still dominate so that differences in the upgrading behaviour of firms are hardly evident. This likewise implies that an enormous growth dividend can be realized once the global economy has recovered from years of distress.

The increasing access to firm-level transactions data now provides vast opportunities to understand the circumstances of different type of firms on a finer level of resolution, and thus, at greater depth. With the extent of firm heterogeneity demonstrated in this paper, analysis based on aggregated trade data is hardly useful. A structured approach to address this firm heterogeneity, instead, would allow one to focus on specific types of firms, on their unique constraints and policy needs. Firms in the most populous sectors, generating only marginal revenues, and facing the highest exit rates due to heightened competition in the most labour-intensive sectors with the lowest entry barriers, are typically ignored in academic and policy research. Yet, a more long-term strategy to diversify exports and expand the manufacturing base will require a more deliberate policy shift towards firms in the lowest base of the revenue pyramid. Moreover, improving the supply chains around these firm-rich sectors could provide diversification paths that are more consistent with the current set of capabilities and resources of developing countries.

Being part of a regional production network can contribute to sustainable development, but only under specific conditions. The experience of the Philippines provides evidence that this is not a simple proposition. Participation in GPNs is no-doubt a blessing in terms of market access, potential technological spill-overs and exposure to higher quality standards and demand. However, the risk of being 'trapped' in the low value-added segments of packaging, assembly or testing (in the case of semiconductors and electronics), can only increase for middle-income countries like the Philippines, especially as their lower-income counterparts with rich reserves of labour stabilize and open up. Indeed, it is not too far-fetched to expect this to materialize from the African region, for instance. The shift towards higher quality varieties will not only be a long drawn out process, but will also be replete with

obstacles as countries chase to few large global firms with generous sets of incentives, in their scramble to be chosen as 'hubs' in GPNs. Since these GPN firms are typically large repositories of relatively low-skilled labour, it is a policy imperative to address safety-net issues in the eventuality of factory closures in the short-run, and in a more proactive and preventive sense, engage with foreign lead firms and monitor the developments in their locational strategies. These networks are also guided by the strategic decision of a number of key (leader) firms, so that the actual future of a supplier firm (partly) will depend on the position it is able to obtain vis-à-vis the strategic intentions of these firm. Macro-economic (trade) data and policy measures do not provide sufficient sophistication to properly assess these mechanisms. Economic studies, such as this paper, could only detect the relationship between upgrading and broad factors such as firm ownership and size, but eventually, the determining motives lie within the confines of multinational boardrooms, far from the reach of even the most extensive data and analysis.

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Appendix

Table A1 Sectoral Classifications

Sectors	Description	PSCC 7-digit	Total lines
1	Food & Animals / Beverages & Tobacco / Crude Mtls	0011101 - 2929909	1,007
2	Minerals Fuels, Lubricants, Related Mtls/Animal & Vegetable Oils, Fats & Waxes	3212100 – 4222900	66
3	Chemicals and Related Products, N.E.S.	5111100 - 5989929	656
4	Manufactured goods classified chiefly by material	6112000 - 6999909	1,243
5	Travel Goods, Handbags, Apparel & Clothing, Footwear	8311100 -8519009	458
6	Furniture and parts thereof; bedding, mattresses, mattress supports, cushions and similar stuffed furnishings	8211100 -8218000	48
7	Professional, scientific and controlling instruments and apparatus, n.e.s Photographic apparatus, equipment and supplies and optical goods, n.e.s.; watches and clocks	8711100 -8859919	212
8	Other Miscellaneous Manufactured Articles	8110001 - 8139909 8911300 – 8989019 8998200 - 8999708	272 30
9	Handicrafts	8991101 - 8997919	74
10	Footwear, Garments (materials on consignment basis)	9310201 - 9310219	14
11	Machinery, Office Machines	7111101 – 7599800	530
12	Telecommunications and sound recording and reproducing apparatus and equipment; Electrical machinery, apparatus and appliances, n.e.s. and electrical parts thereof(including non-electrical conterparts n.e.s. of electrical house-hold type equipment; Watches & Electrical Mach (mtls. on consign.basis)	7611001 – 7762919 7781101 - 7788900	236 96 2
13	Diodes, Semiconductor devices, Integrated Circuits, Microassemblies; Dice of any material; Semiconductor devices (mtls. on consign.basis)	7763100 – 7768900 9310111 -9310119 9310221 -9310222	20 2 2
14	Road Vehicles	7811001 - 7939900	111
15	Others Samples	9310109 9110000; 9310123	2

Table 2a **Characteristics of GPN firm clusters**

	Median	***GPN1***	***CL 3*** net importer (medium)	***CL 4*** net importer (large)	***CL 5*** net exporter (large)
Number of Firms		232	64	18	12
Share in Total Export Rev.		50%	15%	14%	13%
Export Values (US$ M)/firm	2.2	284	406	2040	3050
Import Values (US$ M)/firm	4.4	212	607	2410	1910
Trade balance/firm (US$ M)	0.01	55	17	299	57
Export Unit Values	12	59	71	170	195
Import Unit Values	22	115	194	425	342
Number of Export products	17	88	144	196	162
Number of Import products	60	414	872	1252	526
Number of Export destinations	8	40	58	86	77
Number of Import sources	11	30	50	67	44
Export Transactions/year	6	47	71	122	208
Import Transactions/year	14	144	118	240	305

Source: Authors own computation, data from the Philippine Statistical Authority.