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# Backward and Forward Integration Along Global Value Chains

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**Abstract**
Both backward (upstream) and forward (downstream) vertical integration strategies shape the organization of global value chains (GVCs). Yet, many studies make the unrealistic assumption that integration decisions are binary and one-directional. That is, for each production stage, companies make the integration decision only once, and this can be either backward or forward but not in both directions. The aim of this paper is to analyze the firm-level organization of GVCs when both vertical integration decisions are taken into account. Exploiting a global sample of more than 1.4 million firms, we first document how midstream parents, which actually integrate on both directions along the chain, are at least as common as downstream and upstream parents. We then find that parent companies prefer to integrate production stages with a relatively low elasticity of substitution and with a technological proximity on the supply chain. Finally, we provide evidence that more than one subsidiary in a given location can perform the same production stage.

**Keywords** Global value chains · Vertical integration · Property rights theory · Multinational enterprises · Downstreamness · Corporate boundaries

**JEL Classification** F14 · F23 · D23 · G34 · L20

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## 1 Introduction

In 1871, Continental AG was founded in Germany and started its business as a rubber manufacturer. Nowadays, it is one of the largest manufacturers of tires; but, since its foundation, it has extended its range of activities including both backward (upstream) and forward (downstream) tasks along the automotive chain. For example, Continental AG acquired the segment of brakes and chassis in 1998 from ITT Inc. It concluded a deal with Motorola in 2006 to take over the segment of automotive electronic components ant it acquired the VDO brand by Siemens for powertrain and fuel injection systems in 2007. Later, in 2015, the company moved further upstream after the acquisition of the US firm Vejance Technologies, which is a supplier of engineered rubber products.

Consider also Acer: the Taiwanese company started in 1976 as an electronic components importer and became among the top producer of PCs in 2 decades. Upstream, in 1989 Acer partnered with Texas Instruments to produce semiconductors; and in 1998 it partnered with TI for additional electronic components. Downstream, Acer's regional business units took over local assembly, and it started to develop capabilities in distribution activities (Bartlett and Ghoshal 2000).

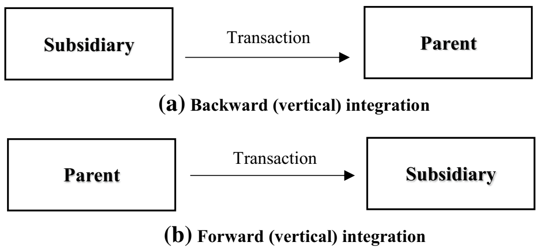
More generally, we may think of many cases in which a manufacturer extends its firm boundary to include other activities both upstream and downstream.

Both backward and forward integration strategies shape the firm-level organization of global value chains (GVCs). From our data, we estimate that they represent about 45% and 35%, respectively, of all parent-subsidiary relationships. Yet, many studies make the unrealistic assumption that integration decisions are one-directional and binary: that is, companies can go either backward or forward but not in both directions and only one supplier is needed for the specific input. For example, there is the voluminous trade literature that was inspired by Antràs (2003) and followed by Antràs and Chor (2013) and Alfaro et al. (2019), who model integration as always starting from the bottom of the supply chain; consequently, the coexistence of forward and backward integration choices (from now on, VIF and VIB, respectively) is assumed away. If the two types of integration coexist and are driven by different mechanisms, any empirical exercise that is based on the one-directional assumption may well be biased.

The aim of this paper is to analyze the firm-level organization of GVCs when both VIB and VIF decisions are taken into account. To this end, we adopt a framework in which production processes are sequential on an ideal supply chain. Therefore, GVCs can be organized in two organizational modes: (1) firms exchange goods at arm's length when they sign supply contracts (outsourcing); or (2) firms integrate one or more production stages after establishing new affiliates or taking over companies that will eventually exchange intermediate goods intra-firm, within the boundary of the group that may stretch across national borders.

The latter case is visualized in Fig. 1, where the principal (a parent firm) can decide to integrate an agent (a subsidiary) under a unique firm boundary. The arrows indicate the transaction direction. In the VIB case, the buyer (parent)

**Fig. 1** Backward and forward integration along GVCs




employs the supplier (subsidiary) of an intermediate input, whereas in the VIF case the supplier (parent) of the intermediate input employs one of its buyers (subsidiaries).

For our purpose, we exploit a sample of 201,272 multinational enterprises (MNEs) that control about 1.2 million domestic or foreign subsidiaries. Then, we further identify newly established subsidiaries or takeovers that were completed in the period 2004–2012.

First, we find that parent companies are more likely to integrate production stages that have a relatively low elasticity of substitution—whether as a buyer or a supplier in an input–output relationship—possibly because an underinvestment by a low substitutable firm would undermine the value that is generated at the end of the chain. In this framework, we rely partially on the intuition by Antràs and Chor (2013), although they assume that only final producers can start integration, which excludes VIF. Yet, they were the first to introduce the notion of interdependence along the GVCs, where all buyers and suppliers must rely on a partition of the final surplus.

We believe that the latter is a peculiar characteristic of fragmented production processes that are oriented over a technological sequence. This is also in line with the original assumption of the contract theory of the firm that was sketched in the seminal work by Grossman and Hart (1986) and Hart and Moore (1990) whereby, in presence of incomplete contracts, vertical integration helps mitigate inefficiencies that arise from underinvestment, and the party whose marginal investment is more relevant should start integration.

Second, we find that integrated activities—both VIF and VIB—tend to be proximate on a supply chain: a parent company is less likely to integrate subsidiaries if they perform activities that are technologically remote from its core activity. Such a proximity on supply chains can be explained by the existence of economies of scope across similar stages, when it is easier to coordinate activities that share some technological features (Del Prete and Rungi 2017).

Finally, we provide evidence of a multiplication of subsidiaries that perform the same production stages in a given location. As far as we know, the latter is a largely unexplored fact that paves the way for an understanding of an important organizational characteristic of GVCs. We find that for 26% of cases in our sample the activity by a subsidiary is a duplicate at the industry–country level. This is consistent with Atalay et al. (2019), who provide a first rationale for the duplication of integrated stages: they found that having an additional vertically integrated establishment in a given destination ZIP code within the US has the same effect on shipment volumes as a 40% reduction in distance.

To grasp the essential aspects of our main findings, let us consider three case studies of downstream, midstream, and upstream parents from our data that are reported in the upper, middle, and bottom panels, respectively, of Fig. 2. For each case, we plot the relative positions on the supply chain of both the parent company and its affiliates.[1]

First, we show Daimler AG—a German multinational automotive corporation that is headquartered in Stuttgart, Baden-Württemberg—which presents a downstreamness measure of 0.99, quite close to final demand. The German corporation controls 357 subsidiaries around the world; all are located relatively more upstream than the parent company: performing production processes that supply inputs that are required for the core activity of the headquarters. Hence, we consider them as choices of backward integration. Of these subsidiaries, 62% are a duplicate at the country–industry level within the firm boundary: there is more than one subsidiary in Daimler AG that performs the same production stage in a given location.

Second, we report a case of a midstream parent company—Continental AG—which is a leading German automotive manufacturer specialized in tires, brake systems, and other parts for the automotive and transportation industries. It has a downstreamness of 0.69 and controls 279 affiliates, which are located both upstream and downstream along the chain: the headquarter of Continental AG receives inputs from some subsidiaries, but also delivers inputs to other subsidiaries along the automotive supply chain. In total, there is a redundancy of 59% subsidiaries within Continental AG that perform the same production stage.

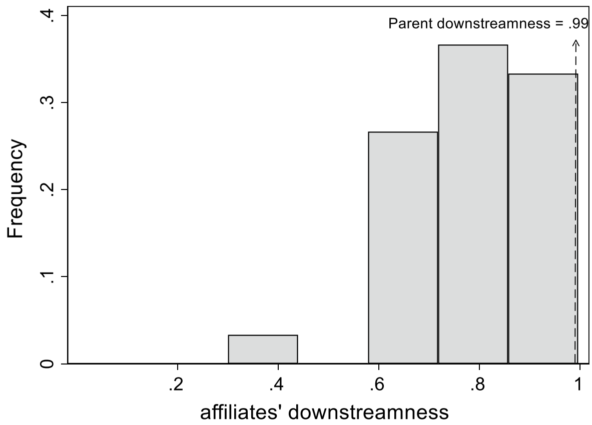
Finally, we report the case of ArcelorMittal: the world's largest steel producer headquartered in Luxembourg City. This is a typical case of forward integration. Its headquarters are upstream, with a downstreamness measure of 0.3, which has integrated over time 631 downstream affiliates. In the case of ArcelorMittal, we also find a remarkable share of production stages duplicated within the firm boundary: 67%.

In sum, it is common in our data to find a multiplicity of organizational modes—including both VIF and VIB and a duplication of production stages along the supply chain. From our point of view, these findings violate the main stringent assumptions of existing theoretical models of GVCs, according to which integration always starts from either the top or the bottom of the supply chain, and only one supplier of an intermediate input is needed for the technological sequence.

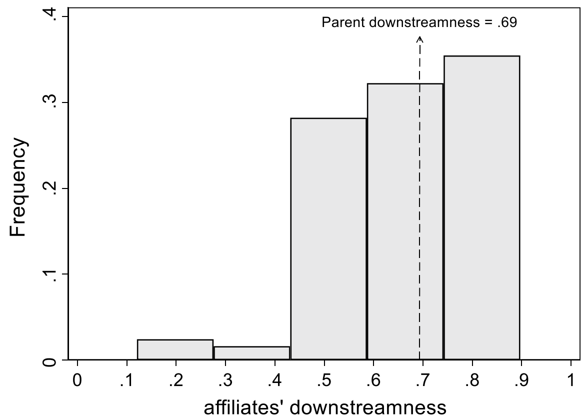
The remainder of this paper is organized as follows. In Sect. 2, we briefly review related works. Section 3 introduces the construction of our sample and first evidence from descriptive statistics. In Sect. 4, we present empirical analyses and robustness checks. Section 5 concludes.

[1] Downstreamness metrics are sourced from Antràs and Chor (2013). See Sect. 3 for more details on how firm-level data are matched by industry affiliations with industry characteristics.

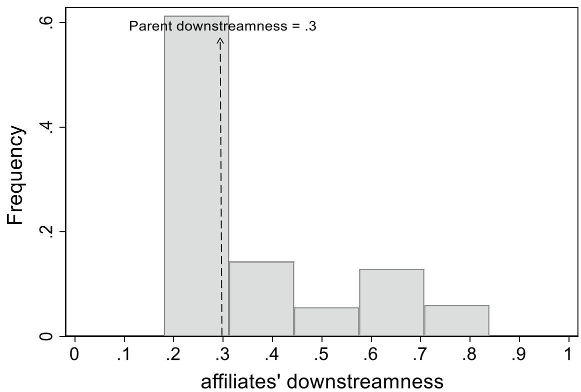
**Fig. 2** Cases of **a** downstream, **b** midstream, and **c** upstream parent companies




**(a)** Daimler AG




**(b)** Continental AG




**(c)** ArcelorMittal

## 2 Literature Review

Several works investigated the determinants of either forward or backward vertical integration. Lafontaine and Slade (2007) categorize this voluminous literature by the direction of integration and the type of industry under study. According to these authors, the empirical literature on forward integration generally considers a manufacturer's decision to sell its outputs directly to consumers, by reaching them through premises it owns, rather than using independent retailers. In this case, the main sector under investigation is the retail industry. Examples include: Lafontaine (1992), who assesses various agency-theoretic explanations for franchising; Minkler and Park (1994) study the role of asset specificity; Scott (1995) investigates system quality in VFI decisions; Lafontaine and Shaw (1999) provide evidence on how franchisors adjust their royalty rates and fees as they gain franchising experience; Woodruff (2002) examines patterns of forward integration among footwear manufacturers and retailers in Mexico; Baker and Hubbard (2004) investigate how contractual incompleteness affects asset ownership in trucking.

On the other hand, the literature on backward integration is concerned with a manufacturer's decision to integrate with its suppliers of parts or equipment: the decision whether to *'make or buy'* an input. This approach has gained popularity in trade literature thanks to the seminal paper by Antràs (2003), who shows how intra-firm trade is mainly concentrated in capital-intensive industries and between capital-abundant countries. Antràs and Helpman (2004) argue that only the most productive firms are able to sustain the higher sunk costs of international vertical integration, which would explain the positive correlation between intra-firm trade and productivity dispersions. It is worth noting that a key assumption in both of these works is that the intermediate input is produced in the foreign subsidiary's country and is then shipped to the headquarters country: a VIB case. If these imports would have instead been shipped from a foreign parent to a U.S. subsidiary, then this assumption would be no longer realistic. From a broader perspective, Acemoglu et al. (2007) are the first to consider the possibility that unique headquarters commit to contracts with several suppliers, in this way extending in scope the one-shot*'make or buy'* decision. They show that a greater contractual incompleteness leads to the adoption of less advanced technologies, even more when intermediate inputs are highly complementary. Finally, it is only recently that a VIB framework has been applied to the sequential nature of production in GVCs (Antràs and Chor 2013; Alfaro et al. 2019), when discussing how the optimal allocation of ownership rights along the chain crucially depends on two main parameters: the positions of suppliers along the sequence; and the relative size of elasticities of final demand *vis à vis* the elasticity of substitution across production stages. In that framework, the final producer posts contracts for agents for each stage, stating the organizational mode (integration or outsourcing), and then chooses for each stage only one agent among the applicants. It will eventually outsource downstream stages and integrate upstream ones when it faces a relatively high demand elasticity.

In all previous cases, however, the integration decision is assumed to be made by a final good producer that picks among its input suppliers, or by a manufacturer towards its retailers. In the first case, the assumption that the most downstream producer is the decision-maker excludes the possibility of forward integration. On the other hand, the assumption that the upstream manufacturer is the principal firm excludes the possibility of backward integration.

Two exceptions are worth mentioning: Acemoglu et al. (2010) develop a theoretical model that allows integration to go either forward or backward. However, in their empirical application, they focus only on VIB cases because their database does not contain information on the direction of integration. They find that both a higher technology intensity of the producer with respect to the supplier and greater cost shares for inputs make vertical integration more likely. More recently, MengXiao (2019) models and tests cases of dual integration—both VIB and VIF[2]—in a context of contractual imperfections. However, both these works do not extend the single *'make or buy'* decision to study technological sequences of GVCs, i.e. by assuming away the case in which two firms share a common parent, the authors neglect the dependence of downstream stages from upstream stages, when production processes are fragmented along GVCs.

## 3 Data

We source data on MNEs from Orbis: a commercial dataset with global coverage that is compiled by the Bureau Van Dijk.[3] We match firm-level primary activities at the 6-digit level of the NAICS classification with similarly disaggregated industrial metrics of positions on supply chains, which are sourced from Antràs and Chor (2013). In the absence of original information on actual shipments of intermediate inputs, Antràs and Chor (2013) turn to the 2002 BEA U.S. I–O Tables[4] to locate an industry along a supply chain, which is measured as the technological distance from final consumers. More specifically, the downstreamness measure is the ratio of the aggregate direct use to the aggregate total use of a particular industry *i*'s goods, where the direct use for a pair of industries is the value of goods from industry *i* directly used by firms in industry *j* to produce final goods, while the total use is the value of goods from industry *i* used either directly or indirectly in producing industry *j*'s output for final goods. A high value of this measure thus suggests that most of the contribution of input *i* tends to occur at relatively downstream production stage close to final demand. Metrics are normalized on a range (0,1), where 0 is the ideal start of a production line and 1 represents final consumption. For similar mappings of firm-level sourcing that is based on input–output tables and industry affiliations,

[2] MengXiao (2019) finds that, if each industry pair is weighted by its total number of seller-buyer relationships, 62% of the industry pairs feature the coexistence of backward and forward integration.

[3] We follow international standards for the identification of parents and subsidiaries of MNEs (OECD 2005; UNCTAD 2009; UNCTAD 2016), according to which a subsidiary is controlled after a (direct or indirect) concentration of voting rights (> 50%). See also Rungi et al. (2019). Similar data structures have been used in Alviarez et al. (2016), Cravino and Levchenko (2016), and Rungi and Del Prete (2018).

[4] We adopt official correspondence tables from NAICS to 2002 I-O industry codes (IO2002) provided by US Bureau of Ecnomic Analysis.

**Table 1** Integrated subsidiaries by organizational mode

| Integration decision: | N. subsidiaries | % |
|---|---|---|
| Backward | 545,044 | 44.6 |
| Forward | 427,725 | 35.0 |
| Horizontal | 249,302 | 20.4 |
| Total | 1,222,072 | 100.00 |

see Alfaro and Charlton (2009), Acemoglu et al. (2010), Alfaro et al. (2016), and Del Prete and Rungi (2017). We complement our data with metrics of demand elasticity sourced from Broda and Weinstein (2006), so as to catch the substitutability of final products and intermediate inputs.

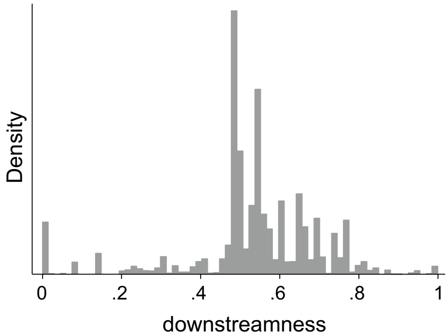
In "Appendix Table 6", we report the geographic coverage of our dataset by origin country: where the parent company is located. Our sample includes information on parents and subsidiaries that are located in 196 countries in 2017. As expected, the European Union reports the highest number of MNEs, in line with official Eurostat FATS statistics. There are fewer MNEs from the US, and they are usually bigger than European MNEs. Both advanced economies and emerging countries are present in our dataset.

Our unit of observation is a pair that comprises a parent company's activity and any possible input and output industry, as derived from I–O tables. Then, following previous studies (Alfaro et al. 2019; Del Prete and Rungi 2017), we consider a stage to be integrated by a parent company if at least one of its subsidiaries is active in an input or output primary industry.[5] If the parent has not integrated any subsidiary in an input (output) industry from the I–O tables, then that good is assumed to be sourced (shipped) from an independent supplier (buyer) outside the firm boundary. Later in this paper, we also consider the number of subsidiaries per production stage.

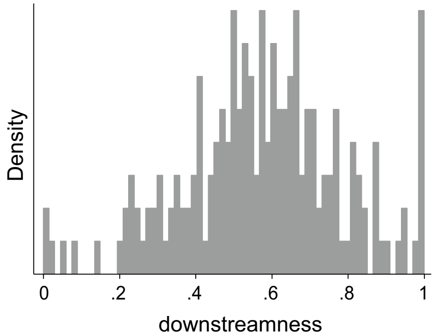
In Table 1, we report the total number of integration strategies included in our sample. VIB and VIF cases are both relatively common, as they represent about 45% and 35% of the total integrated stages, respectively.

In Fig. 3, we show the firm-level positions on a GVC of both parents and integrated firms (subsidiaries) based on their industry affiliations. Interestingly, in both cases, we detect a higher density midstream: when producers are engaged in the production of intermediate goods or services. This is at odds with the main assumptions from existing theories on the organization of GVCs, according to which vertical integration starts from the bottom of the chain, where parents should be, and it involves production stages that are relatively more upstream. In this case, we should find that subsidiaries are on average farther from the final demand than are parent companies.

[5] A key difference with these previous studies is, however, that we also consider output industries. Please note how we make use of primary activities although parents can report several secondary activities different from the primary. In this case, we check that headquarters' secondary activities can be found as primary activities of the subsidiaries in 99.2% of cases.




**(a)** parents




**(b)** subsidiaries

**Fig. 3** Positions of parents and subsidiaries on the GVC

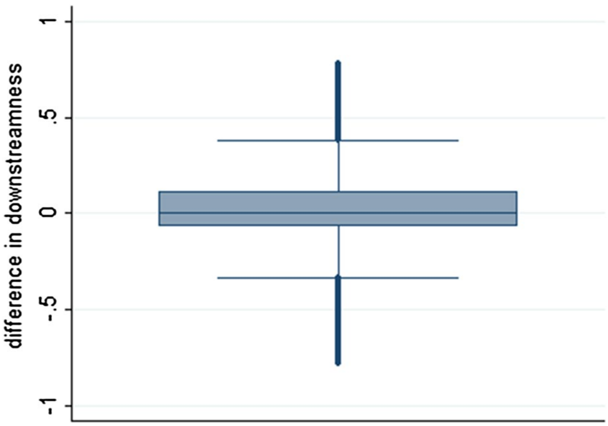



**Fig. 4** Differences in downstreamness between any parent and its subsidiaries

On the contrary, in Fig. 4, when we plot the differences in downstreamness between each parent and any of its subsidiaries, we find that the median value is about zero in our data. Moreover, within-MNE differences in position include both cases where the parent is more downstream than its subsidiary, and cases where the subsidiaries are more downstream than the parent company. As downstreamness metrics encompass a range (0, 1), we note that the interquartile distances that are reported in the boxplot show how the parent companies generally do not move too far along the supply chain for integration decisions. In our case, most integration choices occur in smaller segments along the production sequence, whereas more distant tasks are usually outsourced. We will specifically test this preliminary evidence in the econometric analysis of Sect. 4.1. In "Appendix Table 7", we report descriptive statistics of the industry-pairs variables we are able to observe for alternative downstreamness measures, elasticities of substitution and contractibility for both parent companies and subsidiaries in our sample.

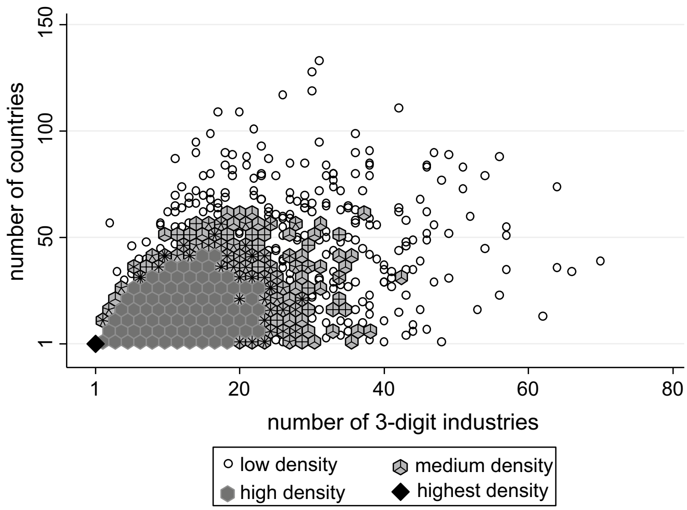



**Fig. 5** Multiple integration choices within MNEs at country–industry level

In Fig. 5, we report some descriptive statistics on the heterogeneity in the extent of vertical integration of the MNEs in our dataset. The diamond-shaped point in Fig. 5 represents 74% of MNEs that integrated only one activity in one industry and in one country. The remaining 26% of MNEs integrated more than one production stage. There are a few instances where parent companies control affiliates that are active in more than 40 input industries and/or locate in more than 50 countries. Such heterogeneity in size after integration choices is largely unaccounted for in the previous literature. We will specifically address this evidence in Sect. 4.2.

## 4 Empirical Results

In this Section, we test the determinants of vertical integration choices along GVCs without any constraint on whether it is a buyer that integrates suppliers or a supplier that integrates a buyer. The first is a case of backward vertical integration (VIB), which has been often studied in most recent trade literature, whereas the second is a case of forward vertical integration (VIF), which was mostly neglected in the study of GVCs, but largely analyzed in the IO literature (see Sect. 2 for further discussion.

Crucially, we rely on the intuitions by Antràs and Chor (2013) and Alfaro et al. (2019), according to which an economic interdependence is established along a supply chain and all suppliers must rely on a final surplus that is realized when the final product is sold on the market. In this framework, three parameters matter for the decision to integrate or not along the supply chain: (1) the relative position on the production sequence; (2) the relative demand elasticities of inputs and final output; and (3) the contractibility of single production stages.

In this contribution, as a purely empirical exercise, we extend that framework to check how these parameters correlate with vertical integration choices when we include VIF cases (in Sect. 4.1), and when we consider a duplication of production processes performed by more than one subsidiary within the same firm boundary: in Sect. 4.2.

### 4.1 Integrating Backward and Forward Stages

We first provide evidence of the parents' decision to integrate either backward or forward, as a function of the relative position on the supply chain, the relative demand elasticities and the contractibility of each production stage with respect to the output of headquarters. In what follows, we always exclude horizontal integration choices—which are identified as activities in the same sector of the parent companies—since these integration decisions may be driven by different motivations: e.g., market-seeking strategies.

To study within-MNE integration decisions, we test a multinomial logit model with three possible choices—outsourcing; backward integration (VIB); and forward integration (VIF)—in the form:

$$\eta_{jkm} = \log \frac{\pi_{km}}{\pi_{kM}} = \alpha_m + \boldsymbol{x}'_k \beta_m,$$

where the $M$-th base decision is an outsourcing strategy, against which the odds of $m = \{VIB, VIF\}$ are tested. The dependent variable is constructed considering whether at least one subsidiary exists in an MNE that operates in a production stage that is classified according to 6-digit U.S. I–O tables that are sourced from the Bureau of Economic Analysis. If the subsidiary is located more upstream than the parent, we have a VIB case; and if the parent is located more upstream than the subsidiary, we have a VIF case.

The vector of $k$-th stage-specific regressors, $\boldsymbol{x}'_k$, includes: the (absolute value of the) difference between the downstreamness of the parent and the downstreamness of the stage, so as to capture how far from the parent the decision to integrate falls; and the log difference between the demand elasticity of the parent output and the demand elasticity of the production stage, so as to capture who has the highest bargaining power on the final markets. Finally, the own-contractibility of the single stage is included as following the methodology of Nunn (2007), in line with the liberal classification by Rauch (1999): a non-contractible input is neither reference-priced nor traded on an organized exchange. Parent-level fixed effects are included, and errors are clustered by parent companies.

Table 2 reports results that are expressed as relative risk ratios. In column 1, we start considering the entire sample; and in the following columns we consider choices by parent companies that originated in the European Union, North America, and Asia, respectively.

Interestingly, we find that results on both backward and forward integration are quite symmetric for the determinants that we include in our specification, and the coefficients are just slightly different in magnitude across geographic areas. The relative risk ratios on differential downstreamness are always smaller than one, which implies that we have lower odds that an integrated stage will be far from

**Table 2** Multinomial logit for backward and forward integration *vis à vis* outsourcing strategies

| | (1) All countries | (2) European Union | (3) North America | (4) Asia and Africa |
|---|---|---|---|---|
| *Backward integration* | | | | |
| Differential downstreamness | 0.378*** | 0.330*** | 0.184*** | 0.514*** |
| | (0.029) | (0.031) | (0.043) | (0.080) |
| Differential elasticity | 1.745*** | 1.787*** | 1.780*** | 1.712*** |
| | (0.030) | (0.041) | (0.099) | (0.059) |
| Contractibility | 0.275*** | 0.240*** | 0.099*** | 0.337*** |
| | (0.025) | (0.031) | (0.038) | (0.057) |
| Constant | 0.004*** | 0.005*** | 0.007*** | 0.011*** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| *Forward integration* | | | | |
| Differential downstreamness | 0.537*** | 0.774*** | 0.145*** | 0.474*** |
| | (0.059) | (0.142) | (0.036) | (0.081) |
| Differential elasticity | 1.422*** | 1.473*** | 1.361*** | 1.376*** |
| | (0.028) | (0.043) | (0.074) | (0.049) |
| Contractibility | 0.317*** | 0.314*** | 0.077*** | 0.402*** |
| | (0.035) | (0.052) | (0.033) | (0.073) |
| Constant | 0.004*** | 0.003*** | 0.008*** | 0.010*** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Observations | 2,291,795 | 1,468,852 | 418,104 | 333,672 |
| Pseudo $R^2$ | 0.0092 | 0.0100 | 0.007 | 0.0083 |
| Log pseudolikelihood | − 149,590.0 | − 79,992.3 | − 36,138.6 | − 38,343.2 |
| Parent company FEs | Yes | Yes | Yes | Yes |

Multinomial model with a control group based on the choice of outsourcing. Relative risk ratios are reported. Downstreamness is sourced from Antràs and Chor (2013). Elasticities of substitutions are sourced from Broda and Weinstein (2006). Contractibility is calculated following Rauch (1999), sourced from Antràs and Chor (2013). Standard errors clustered at parent level in parentheses

***, **, *stand for $p$ value < 0.01, $p$ value < 0.05 and $p$ value < 0.10, respectively

the parent company from a technological point of view, which is in line with what we observed in Fig. 4. This is what was already found by Del Prete and Rungi (2017), in a context where VIF cases were not explicitly considered.

Furthermore, the relative risk ratios on the differential elasticity of substitution are always significantly higher than one, which implies that the parent company will more likely integrate activities with a relatively lower elasticity of substitution, as it is also the side whose underinvestment could reduce relatively less the final surplus that is realized on the market.

Finally, the relative risk ratios on industry-level contractibility are always significantly lower than one, which means that less contractible inputs are more

**Table 3** Robustness checks on the multinomial choice of integration

| | (1) Downmeasure | (2) Conservative measure of contract-ibility | (3) Top 100 input–output relationships | (4) Manu-facturing parents |
|---|---|---|---|---|
| *Backward integration* | | | | |
| Differential downstream-ness | 0.431*** | 0.385*** | 0.370*** | 0.701*** |
| | (0.023) | (0.029) | (0.020) | (0.102) |
| Differential elasticity | 1.765*** | 1.614*** | 1.805*** | 1.928*** |
| | (0.030) | (0.029) | (0.013) | (0.053) |
| Contractibility | 0.260*** | 0.399*** | 0.180*** | 0.102*** |
| | (0.024) | (0.014) | (0.016) | (0.019) |
| Constant | 0.006*** | 0.007*** | 0.009*** | 0.008*** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| *Forward integration* | | | | |
| Differential downstream-ness | 0.183*** | 0.522*** | 0.175*** | 0.359*** |
| | (0.023) | (0.058) | (0.022) | (0.041) |
| Differential elasticity | 1.404*** | 1.586*** | 1.030*** | 1.510*** |
| | (0.028) | (0.032) | (0.021) | (0.041) |
| Contractibility | 0.295*** | 0.258*** | 0.218*** | 0.288*** |
| | (0.032) | (0.039) | (0.024) | (0.047) |
| Constant | 0.005*** | 0.004*** | 0.006*** | 0.009*** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Observations | 2,291,795 | 2,291,795 | 958,400 | 629,803 |
| Pseudo $R^2$ | 0.0110 | 0.0116 | 0.0070 | 0.0129 |
| Log pseudolikelihood | − 149,314.2 | − 149,219.8 | − 69,914.3 | − 63,784.8 |
| Parent company FEs | Yes | Yes | Yes | Yes |

Multinomial model with a control group based on the choice of outsourcing. Relative risk ratios are reported. Downstreamness is sourced from Antràs and Chor (2013). Elasticities of substitutions are sourced from Broda and Weinstein (2006). Contractibility is calculated following Rauch (1999), sourced from Antràs and Chor (2013). Standard errors clustered at parent level in parentheses

***, **, *stand for $p$ value < 0.01, $p$ value < 0.05 and $p$ value < 0.10, respectively

likely to be integrated than are more contractible ones, which is in line with main tenets of the property rights theory of the firm.[6]

Notably, in North America, including the US, Canada, and Mexico, the relative risk ratios on differential downstreamness and contractibility of either VIB or VIF with respect to an outsourcing strategy have the lowest magnitudes. In this case, it is possible that the good institutional environment in the origin country plays a role,

[6] There are also recurrent yet counterintuitive results of positive effects of contractibility on integration in the property rights literature (Baker and Hubbard 2004; Nunn and Trefler 2013; Defever and Toubal 2013).

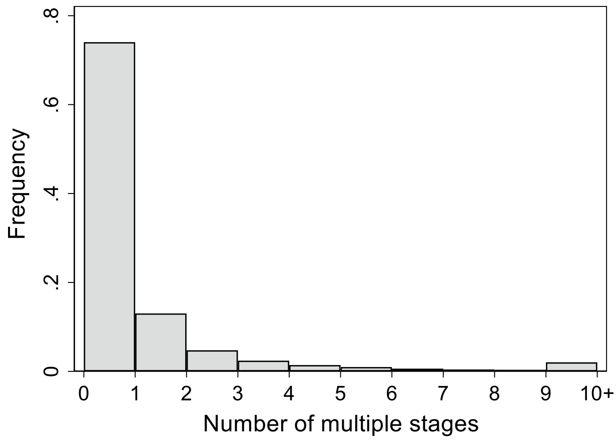



**Fig. 6** Unique and multiple production stages performed by affiliates

and the parent companies can better enforce their contracts in outsourced activities, as compared with other origin countries.

In Table 3 we introduce some checks on the robustness of our results: In the first column, we exploit an alternative measure of downstreamness (*DownMeasure*) that was proposed by Antràs and Chor (2013), which further discounts more upstream stages of production. In the second column, we switch to the more conservative measure of contractibility that was originally proposed by Rauch (1999), which considers only the share of differentiated versus undifferentiated products while excluding products with reference-prices. In column 3, we reduce integration choices by considering only the top 100 input–output exchanges with the highest direct requirement coefficients in the I–O tables, so as to avoid including stages that are less likely to be in a trade relationship. In column 4, we include in our sample only the parent companies whose core activity is a manufacturing product, to exclude activities that are less related to GVC—such as finance and non-tradable services. Please note that the main findings from Table 3 follow the patterns of the baseline in Table 2, although with slight differences in the magnitude of the coefficients.

### 4.2 Duplicating Stages Along the GVC

In this section, we investigate whether and how more than one subsidiary controlled by a parent can perform the same production stage in a given location within its corporate boundary. To this aim, we modify our data structure, in line with Del Prete and Rungi (2017), to consider only those stages that were integrated: we discard the parent-industry dimension and switch to a parent-and-affiliate level dimension. Consequently, our unit of observation is a pair that is made from a parent company (taken with its output) and any of its controlled affiliates. From our total sample, we further select those parents that concluded at least one deal in the period 2004–2012, for which we have information on new incorporations and takeovers.

The duplication of production stages—which is considered along with both the country and the industrial 6-digit NAICS rev. 2007 dimensions—is a systematic feature of the corporate boundaries that we observed in Fig. 5. In Fig. 6, we report some more details on the relevance of this phenomenon. Although the majority of affiliates (74%) are unique within corporate boundaries as they are the only productive units that are devoted to the completion of a production stage in a location, a non-negligible share—26%—of subsidiaries perform tasks that are already operated by other co-subsidiaries in a given location.[7] Among these, 13% are tasks that are performed by two co-subsidiaries, and 5% are performed by three co-subsidiaries, up to a maximum of 446 redundancies within an MNE boundary.

To study multiple integration decisions, we start by testing a linear probability model[8] with country-level fixed effects as:

$$\begin{aligned} Multiple_{ijkc} = {} & \beta_0 + \beta_1 Differential\ downstreamness_{ijkc} \\ & + \beta_2 Differential\ elasticity_{ijkc} + \beta_3 Contractibility_{ikc} \\ & + \beta_4 X_j + \mu_c + \varepsilon_{mj} \end{aligned}$$

where $Multiple_{ijkc}$ is a binary variable equal to one when the parent $j$ has integrated at least two affiliates $i$ active in the same industry $k$ located in the same country $c$, and zero otherwise. The coefficients $\beta_1$ and $\beta_2$ catch the correlation with the absolute difference between the downstreamness of the parent $j$ and that of the affiliate $i$ and the log difference of the two elasticities of substitution, respectively. $Contractibility_{ikc}$ is a proxy for the ability to sign a complete contract with a supplier in the industry of the subsidiary (Rauch 1999). $X_j$ are parent level controls, namely the number of affiliates within the group, productivity, capital intensity, size and age. Finally, we introduce a full set of country-level fixed effects ($\mu_c$).

Table 4 shows that the farther is the affiliate from the parent—either upstream or downstream—the less likely is a duplication of stage within a country, as the coefficient on *differential downstreamness* is significantly and negatively correlated with the dependent variable. Consistent with recent literature, we find that firms that are under common ownership tend to be proximate to the parent on a supply chain (Del Prete and Rungi 2017) and geographically closer to one another (Antràs and De Gortari 2020; Atalay et al. 2019). Newer to the existing literature is the joint decision to co-locate more than one subsidiary that performs exactly the same production stage in the same country. We argue that such proximity—both in space and along the GVC—allows a parent more easily to coordinate activities of the integrated firms,

[7] The duplication of tasks also exists when we check for'pure' vertical integration strategies—excluding horizontal integration decisions—for affiliates that report the same downstreamness of the parent. In this case we find that 24% of affiliates perform tasks that are already integrated within the corporate boundary.

[8] In Table 8 in "Appendix", we show that our results are robust to the implementation of a probit model.

**Table 4** Duplicating stages along GVCs

| | (1) | (2) | (3) |
|---|---|---|---|
| Differential downstreamness | −0.426*** | −0.500*** | −0.525*** |
| | (0.025) | (0.052) | (0.044) |
| Differential elasticity | | 0.006 | −0.007 |
| | | (0.006) | (0.006) |
| Contractibility | | 0.105*** | 0.081** |
| | | (0.026) | (0.033) |
| Number of affiliates | | | 0.041*** |
| | | | (0.009) |
| Productivity | | | −0.005 |
| | | | (0.007) |
| Capital intensity | | | 0.033*** |
| | | | (0.007) |
| Size | | | 0.012** |
| | | | (0.006) |
| Age | | | −0.024** |
| | | | (0.010) |
| Constant | 0.149*** | 0.281*** | −0.157** |
| | (0.054) | (0.045) | (0.063) |
| Observations | 260,333 | 72,487 | 58,032 |
| $R^2$ | 0.102 | 0.104 | 0.160 |
| Country FEs | Yes | Yes | Yes |

Downstreamness is sourced from Antràs and Chor (2013). Elasticities of substitutions are sourced from Broda and Weinstein (2006). Contractibility is calculated following Rauch (1999), sourced from Antràs and Chor (2013). Standard errors clustered at parent level in parentheses

***, **, *stand for $p$ value < 0.01, $p$ value < 0.05 and $p$ value < 0.10, respectively

thereby possibly increasing those firms' productivity and, in turn, profitability—as, for example, has been tested by Giroud (2013) and Kalnins and Lafontaine (2004, 2013).

Also, while the elasticities of substitution do not seem to play a role in the duplication of stages, we find that greater contractibility at a stage correlates with the presence of more subsidiaries that are involved in its production process. It may be due to the fact that complex or highly differentiated inputs, which entail a higher risk of imitation when technology may leak to competing producers, tend indeed not to be dispersed among several units. Finally, as expected, we also find that bigger, younger, and more capital-intensive MNEs are more likely to duplicate stages of production.

**Table 5** Sample compositions for the integration of duplicated stages

| | (1) No horizontal | (2) VIB | (3) VIF | (4) Manufacturing parents | (5) New investments | (6) Number of multiple stages |
|---|---|---|---|---|---|---|
| Differential downstreamness | −0.116*** | −0.086* | −0.152*** | −0.316*** | −0.508*** | −1.640*** |
| | (0.039) | (0.051) | (0.056) | (0.039) | (0.045) | (0.202) |
| Differential elasticity | −0.001 | 0.006 | −0.010 | −0.001 | −0.032*** | −0.042* |
| | (0.006) | (0.008) | (0.008) | (0.007) | (0.008) | (0.023) |
| Contractibility | 0.085** | 0.090** | 0.062 | 0.148*** | 0.139*** | −0.064 |
| | (0.040) | (0.042) | (0.083) | (0.039) | (0.043) | (0.118) |
| Constant | −0.276*** | −0.318*** | −0.227*** | −0.345*** | −0.241*** | −0.524** |
| | (0.060) | (0.065) | (0.085) | (0.067) | (0.068) | (0.236) |
| Observations | 43,017 | 23,083 | 19,934 | 39,808 | 19,452 | 58,396 |
| $R^2$ | 0.122 | 0.133 | 0.119 | 0.145 | 0.178 | 0.244 |
| Country FEs | Yes | Yes | Yes | Yes | Yes | Yes |
| Firm ctrls | Yes | Yes | Yes | Yes | Yes | Yes |

Downstreamness is sourced from Antràs and Chor (2013). Elasticities of substitutions are sourced from Broda and Weinstein (2006). Contractibility is calculated following Rauch (1999), sourced from Antràs and Chor (2013). Standard errors clustered at parent level in parentheses

***, **, *stand for $p$ value < 0.01, $p$ value < 0.05 and $p$ value < 0.10, respectively

In Table 5, we check whether our previous results are robust to sample compositions. We first exclude horizontal strategies. Then we include only either VIB or VIF. In column 4, we exclusively consider manufacturing parents, while in column 5 we test only new investments in our sample: those that occurred between 2004 and 2012, for which we have information on new incorporations and takeovers. In the last column, in place of a dummy variable, we use the number of multiple stages as a dependent variable. In all of these cases our main findings are confirmed.

## 5 Conclusions

The voluminous literature on vertical integration choices has largely neglected the possibility that firms may find it optimal to integrate both upstream and downstream along the supply chain. A key assumption of those models is that integration decisions are one-directional: companies can go either backward or forward but not in both directions.

In this paper, using a global dataset of activities by MNEs, we first document the coexistence of backward and forward integration strategies along the GVCs. Second, our results show that the decision to integrate falls on activities with a relatively low elasticity of substitution and tends to target production stages that are technologically closer along the chain—possibly to maximize coordination efforts. Finally, we systematically find a duplication of production stages in our data, as they are performed by different subsidiaries within the same corporate boundary.

The above results call for a re-assessment of existing theoretical models, so as to incorporate the greater flexibility and redundancy of vertical integration that these results show.

## Appendix

See Tables 6, 7 and 8.

**Table 6** Sample coverage

| Origin country | Parent companies | % | Domestic subsidiaries | % | Foreign subsidiaries | % |
|---|---|---|---|---|---|---|
| European Union | 111,522 | 55.41 | 233,714 | 46.77 | 408,674 | 56.58 |
| *of which*: | | | | | | |
| Germany | 11,261 | 5.59 | 36,759 | 7.36 | 44,135 | 6.11 |
| France | 6650 | 3.30 | 25,905 | 5.18 | 39,949 | 5.53 |
| United Kingdom | 12,361 | 6.14 | 44,266 | 8.86 | 57,820 | 8.00 |
| Italy | 8680 | 4.31 | 17,362 | 3.47 | 26,800 | 3.71 |
| Spain | 5530 | 2.75 | 22,043 | 4.41 | 19,826 | 2.74 |
| United States | 22,511 | 11.18 | 133,205 | 26.66 | 115,339 | 15.97 |
| Russia | 974 | 0.48 | 2432 | 0.49 | 1597 | 0.22 |
| Asia | 19,142 | 9.51 | 71,849 | 14.38 | 114,707 | 15.88 |
| *of which*: | | | | | | |
| Japan | 3259 | 1.62 | 25,749 | 5.15 | 33,789 | 4.68 |
| China | 2995 | 1.49 | 10,076 | 2.02 | 6111 | 0.85 |
| India | 1501 | 0.75 | 4357 | 0.87 | 6479 | 0.90 |
| Africa | 4169 | 2.07 | 6027 | 1.21 | 12,791 | 1.77 |
| Latin America | 18,247 | 9.07 | 3262 | 0.65 | 10,273 | 1.42 |
| *of which*: | | | | | | |
| Brazil | 342 | 0.17 | 1196 | 0.24 | 2334 | 0.32 |
| Argentina | 126 | 0.06 | 187 | 0.04 | 239 | 0.03 |
| Mexico | 322 | 0.16 | 1041 | 0.21 | 1306 | 0.18 |
| Australia | 2771 | 1.38 | 19,108 | 3.82 | 11,429 | 1.58 |
| Rest of the world | 21,936 | 10.90 | 30,120 | 6.03 | 47,545 | 6.58 |
| **Total** | 201,272 | 100.00 | 499,717 | 100.00 | 722.355 | 100.00 |

**Table 7** Descriptive statistics

| Variable | Mean | SD | Min | Max | N. obs |
|---|---|---|---|---|---|
| Downstreamness parent output (DuseTuse) | 0.582 | 0.225 | 0.000 | 1.000 | 2,291,795 |
| Downstreamness parent output (Down) | 0.580 | 0.232 | 0.215 | 1.000 | 2,291,795 |
| Downstreamness subsidiary output (DuseTuse) | 0.633 | 0.219 | 0.074 | 0.999 | 2,291,795 |
| Downstreamness subsidiary output (Down) | 0.568 | 0.211 | 0.229 | 0.999 | 2,291,795 |
| Elasticity of substitution parent output | 8.851 | 10.126 | 1.300 | 10.850 | 2,291,795 |
| Elasticity of substitution subsidiary output | 7.958 | 9.609 | 1.300 | 10.850 | 2,291,795 |
| Contractibility parent output | 0.023 | 0.101 | 0.000 | 0.884 | 2,291,795 |
| Contractibility subsidiary output | 0.058 | 0.178 | 0.000 | 1.000 | 2,291,795 |

The unit of observation is any parent-industry pair observed in Tables 2 and 3. Downstreamness measures are sourced from Antràs and Chor (2013). Elasticities of substitutions are sourced from Broda and Weinstein (2006). Contractibility is calculated following Rauch (1999), sourced from Antràs and Chor (2013). For each parent and each subsidiary, we match industry-level measures based on primary 6-digit I–O affililiations as from I–O tables. Correspondence tables NAICS to I–O sectors are sourced from Bureau of Economic Analysis (BEA)

**Table 8** Probit model for duplicating stages along GVCs

| | (1) | (2) | (3) |
|---|---|---|---|
| Differential downstreamness | −0.415*** | −0.496*** | −0.519*** |
| | (0.024) | (0.051) | (0.043) |
| Differential elasticity | | 0.006 | −0.007 |
| | | (0.006) | (0.006) |
| Contractibility | | 0.106*** | 0.083** |
| | | (0.027) | (0.033) |
| Number of affiliates | | | 0.041*** |
| | | | (0.009) |
| Productivity | | | −0.005 |
| | | | (0.007) |
| Capital intensity | | | 0.033*** |
| | | | (0.007) |
| Size | | | 0.012** |
| | | | (0.006) |
| Age | | | −0.025** |
| | | | (0.010) |
| Observations | 260,333 | 72,487 | 58,032 |
| Pseudo $R^2$ | 0.077 | 0.079 | 0.124 |
| Country FEs | Yes | Yes | Yes |

Marginal effects are reported. Downstreamness is sourced from Antràs and Chor (2013). Elasticities of substitutions have been sourced from Broda and Weinstein (2006). Contractibility is calculated following Rauch (1999), sourced from Antràs and Chor (2013). Standard errors clustered at parent level in parentheses

***, **, *stand for $p$ value < 0.01, $p$ value < 0.05 and $p$ value < 0.10, respectively

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