CPB Netherlands Bureau for
Economic Policy Analysis

Productivity, Positions, and Foreign Investment: Dutch Firms in International Production Chains

Dutch firms can be equally productive and profitable at any point in international production chains—from raw material extraction to assembly and sales. While firms at the start of these chains produce more per hour worked, intensive capital use balances out productivity and profitability. Relocating activities abroad generally increases firms' productivity.

Generic policies focused on open markets, innovation, infrastructure, and predictable regulation—preferably coordinated at the European level—seem more promising than national policies targeting specific sectors or positions within the value chain.

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Summary

In recent months, policy discussions about the lack of productivity growth in the Netherlands and the EU played a prominent role. Since 2005, productivity growth in the Netherlands and many other countries worldwide, and at the same time Europe risks lagging behind the United States in this area States. Meanwhile, geopolitical tensions are changing international value chains, import duties, the energy transition, and the emergence of new markets and technologies. These developments have led to a revival of the debate on the usefulness and design of industrial policy in the Netherlands and the EU.

This research focuses on the role of international production chains for the performance of Dutch firms. We investigate the position of Dutch manufacturing firms in these chains, from raw material exports to end product sales, and the impact of exports and foreign investments (FDI, foreign direct investments) on their productivity and profitability. This is essential to gain insight into how Internationalization can help firms improve their performance and what policies can support this process can provide effective support.

Our findings show that there are few systematic differences in productivity across positions in the production chain, especially when we take into account the use of capital. Firms show higher labour productivity on average at the beginning of the chain. This is mainly explained by the intensive use of capital by these firms. The research shows that there is no clear, systematic relationship between position in the chain and productivity or profitability.

Firms that engage in FDI tend to be more productive than exporters or firms that are only active nationally. This can be explained by learning effects. The benefits of FDI tend to be greater for investments outside the EU and for horizontal FDI. However, the effectiveness of foreign investments varies by industry and is mainly beneficial for firms with lower initial productivity. This suggests that internationalisation can help firms in different contexts to improve their productivity.

These findings provide some insights for policies aimed at strengthening the international involvement of Dutch firms. Policy measures such as trade missions, export subsidies and trade agreements can contribute to improving the competitive position of firms and their productivity. However, there is no evidence that firms in specific positions in the production chain are more productive than others. We find considerable variation between firms within industries and within production chain positions. This raises the question whether these categories are a suitable starting point for policymakers when formulating industrial policy. Open markets and the associated possibility for flexible firm adjustments in the production chain remain crucial. Generic policies aimed at promoting innovation, strengthening infrastructure and predictable regulation, coordinated as much as possible at European level, are therefore preferable to national policies that focus on specific industries or clusters.

1 Introduction

Since 2005, productivity growth has slowed in the Netherlands and many other countries worldwide. For a recent study, see Goldin (2024). At the same time, Europe is in danger of lagging behind the United States in terms of productivity growth (Draghi, 2024). This raises questions about the factors that influence productivity, including the role of global value chains. This research focuses on how Dutch firms participate in international production chains and the relationship with productivity and profitability.

More insight into where Dutch firms are in the production process and how they invest abroad (FDI) can provide valuable insights into their performance. This research is twofold. In the first part, conducted by the Netherlands Bureau for Economic Policy Analysis, we analyse exporting firms from the Dutch manufacturing industries and their position in the production chain. This varies from firms that export raw materials or semi-finished products to firms that export complete end products. We investigate to what extent the position of these firms in the production chain is related to their productivity, firm size and profitability. The second part, conducted by Statistics Netherlands, builds on previous research on learning effects of international trade (Franssen et al., 2022). It analyses the FDI involvement of Dutch firms, both within and outside the EU, and its relationship with productivity.

Dutch firms increasingly operate within international production chains. Due to the trade- oriented economy, many firms are intertwined with international production chains. Depending on their activities, they can position themselves at the beginning of production chains, with an emphasis on technology, knowledge and/or raw materials, or at the end of the chain, focused on assembly, distribution and/or final product sales. Some studies suggest that certain production steps are intrinsically more productive than others, as described in the smile curve (Shih, 1996). The smile curve states that most value is created at the beginning and end of production chains, while the middle phase (manufacturing) adds less value. It is important to note that this study focuses on the positions that Dutch firms take within international production chains (how many production steps before a product reaches the end consumer), and not on the specific activities, such as research & development (R&D), assembly or marketing, that can be performed within the different positions.

Firms that invest abroad can save costs by being closer to their suppliers or customers. In vertical FDI, firms relocate part of their production to cheaper locations or more efficient suppliers, while in horizontal FDI, firms perform the same production activities locally in foreign markets. Such investments are mainly made by firms that are already productive. In general, firms with foreign investments perform best, followed by exporters, while firms that are only active domestically have the lowest productivity. Because foreign investments are more expensive and complex than exports, they can also yield greater productivity benefits, for example through access to new technologies and knowledge.

The literature on international value chains (GVCs) has, global value chains) focuses on the following three themes: determinants of participation in value chains, the effects of participation on firm outcomes, and the influence of a firm's position within the chain on performance such as productivity and profitability. Participation in international value chains is influenced by factors such as firm size, geographical proximity to markets and the trading environment, as well as investments in technology and R&D. This participation is often accompanied by higher productivity through specialization and knowledge transfer. Firms realize efficiency gains by focusing on stages of production where they have a comparative advantage. However, the impact on wages and employment is variable and context dependent. Although not all studies provide unanimous evidence, a fair number of empirical studies confirm the 'smile curve' hypothesis, in which firms at the beginning (R&D) and the end (marketing) and sales) of the value chain are on

average more productive and add more value than firms in the middle (manufacturing). For a further overview of this literature, see the appendix.

The literature on FDI and productivity shows that exporters tend to be more productive than non-exporters, a pattern that has been confirmed in several countries. Melitz's (2003) theory predicts that only the most productive firms expand internationally, while other studies indicate that firms actually become more productive through international activities. The evidence for these theories is mixed, with some studies showing learning effects, while others find no clear relationship. Methods such as that of De Loecker (2013) show that firms, such as in Slovenia, learn from exporting, and similar results have been found in other countries. There is also debate about the learning effects, with some studies suggesting that less productive firms learn more from exporting than more productive firms. For a further overview of this literature, see the appendix.

The remainder of the paper is as follows. Chapter 2 describes the research on the relationship between the position of firms in production chains and their productivity and other characteristics. Chapter 3 examines how FDI affects the productivity of firms under different circumstances. Chapter 4 concludes. The appendices contain a further description of the method and data used, a discussion of the literature, the conceptual background and additional results.

2 Positions of Dutch firms in international production chains

A firm's position in international production chains refers to the role it plays in the production process of a good or service, from the raw materials to the final product that reaches the consumer. Firms can be located at different points in this chain. At the beginning are the upstream firms, such as raw material suppliers and basic material producers. They supply essential raw materials, such as metals or chemicals, which are used later in the production process. In the middle of the chain are firms that process these raw materials and produce semi-finished products. These are, for example, component suppliers or assembly firms that make parts for the automotive or electronics industry. At the end of the chain are the downstream firms, such as final assembly firms, brand manufacturers and distributors. They take the final steps in the process by assembling, packaging and selling products to consumers or firms.

Figure 2.1: Schematic representation of a value chain

The position in the chain is measured upstreamness -measure that indicates how 'far' a with a production process removed from the end user. This is indicated by in figure 2.1. In other words, it measures how many steps are needed to make a certain product into a final product. A high upstreamness means (firm j in figure 2.1) that the industry or firm is located earlier in the chain (for example, at raw materials or base materials), while a low upstreamness (firm i in figure 2.1) indicates that production is closer to the end consumer. The firm-level measure is established in several steps.

To apply this analysis at the firm level, the composition of imports and exports is examined for each firm.[1] These trade flows of firms are then linked to industries, according to the industry that most often produces this product. On this basis, a weighted average is calculated of the upstreamness scores of the industries involved, see the equation below.[2] This average indicates whether a firm is mainly at an early stage of the value chain (for example, as a supplier of raw materials or technology) or at a later stage (such as assembly or sale of finished products). We define upstreamness for a firm i as follows:

$$U_X(i) = \sum_{\rho \in P_i} \omega_i(\rho)\, x(\rho))$$

P_i are the products that firm exports, $\omega_i(\rho)$ is the share of product ρ within firm's total exports, and $x(\rho)$ is the upstreamness of product ρ (according to the upstreamness definition of Antràs et al. (2012)).[3]

This analysis further uses detailed CBS microdata at the firm level, which contains information on

[1] We use trade data from Statistics Netherlands (CBS) that aim to exclude all re-exports.
[2] The position of industries in global value chains is analysed using Eurostat's (2023) FIGARO multi-regional input-output table.
[3] We use the upstreamness of industries, following Chor et al. (2021). Jackson et al. (2024) show that measuring upstreamness at the product level may provide a more accurate approach.

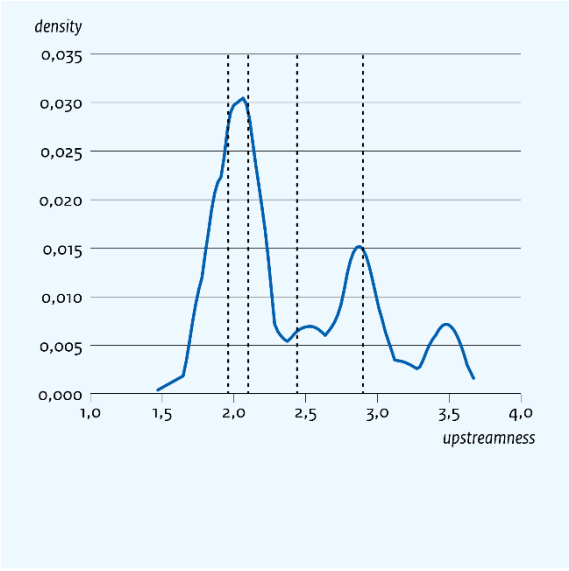
productivity and other firm characteristics. Productivity is measured with two measures: labour productivity and total factor productivity (TFP), using the ACF method to correct for endogeneity problems (following Ackerberg et al., 2015). In addition, we use data on wages, balance sheet data, and additional firm characteristics such as industry, age, and multinational status.

In this section we show patterns of the position of firms in the value chain and their characteristics in terms of capital intensity, firm size, productivity and profitability. There is a (slightly) U-shaped relationship between the value chain position and several firm characteristics such as capital intensity, number of employees, and turnover. This means that both firms that are at the beginning of the production process and firms that are at the beginning of the production process (upstream, focused on raw materials, R&D, specialized technology and advanced production steps) and firms located at the end of the production process (downstream, focused on assembly, final production and distribution) are typically large and capital intensive.

In the appendix we show graphs for each individual variable in levels. We see that the variation between positions is often caused by outliers of firms that are active at one of the two ends of the production process. Both ends of the value chain have small groups of firms that are very large.

The largest number of firms has a position at the end of the chain. Figure 2.2 shows that most of the mass of firms is around an upstreamness value of 2. This means that most firms produce at the end of the production process. In addition, there seem to be a number of clusters around certain values. A cluster in the middle with about 2.8 upstreamness and a cluster around 3.5 at the beginning of the chain.

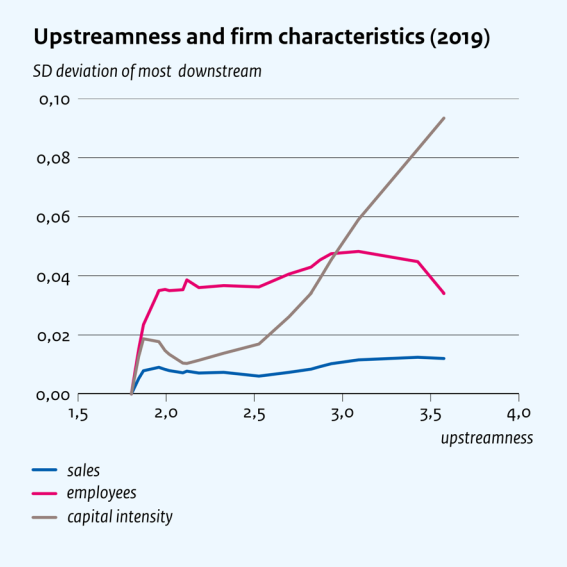
Figure 2.2 Distribution of firms along the value chain



Note: This figure shows a density graph of upstreamness for firms in the manufacturing industry in the year 2019. The four dotted lines show the respective cut-offs of the five quintiles of the distribution. The areas between two such cut-offs each contain 20% of the distribution. The figure goes from left (low upstreamness, i.e. close to the end user) to right (high upstreamness, several production steps away from the end user).

In the middle of the value chain there is a group of smaller firms that operate less capital intensively. Figure 2.3 shows that these medium-sized firms generally have a more limited turnover and number of employees (see also the individual figures in the appendix). This pattern suggests that firms at the beginning and at the end of the chain – for example with a strong focus on technological innovation and knowledge-intensive production, or large-scale production and distribution – structurally require greater investments and resources than firms in the mid-market segment.

Figure 2.3 firm characteristics along the value chain



Note: The lowest point on the horizontal axis is the reference, and the vertical axis shows how many standard deviations more or less the median is at other points in the value chain in comparison. The figure goes from left (low upstreamness, i.e. close to the end user) to right (high upstreamness, several production steps removed from the end user).

The firms at the beginning of the chain pay the highest average wages. This indicates that firms in this position more often perform specialized and knowledge-intensive activities that require highly qualified workers. The higher wages can be explained by a combination of factors, including the higher productivity of these firms, the complexity of the work and the higher added value per employee. In contrast, firms that find themselves at the end of the chain typically has lower wages, which is consistent with a greater reliance on routine production work and less specialized functions.

Foreign multinational enterprises (MNEs) are overrepresented at firms at the beginning of the chain. Foreign firms therefore play an important role in the most technology- and knowledge-intensive parts of the chain, for example through investments in R&D, advanced production processes and the development of innovative technologies. The strong presence of MNEs in this segment may also indicate a greater degree of international cooperation. This may take the form of integration into global value chains, for example, whereby these firms take up strategic positions in the upstream phases of production and innovation.

The analysis does not show a clear pattern regarding the age of firms within the different clusters of the value chain. This means that firms at the beginning, end, as well as the middle segment, contain a mix of younger and older firms. This result suggests that positioning in the value chain is not directly related to the life stage of a firm and that both young and established firms can operate in all segments of the chain. However, the following section shows that industries are an important factor for value chain positions.

2.1 Industries along the production chains

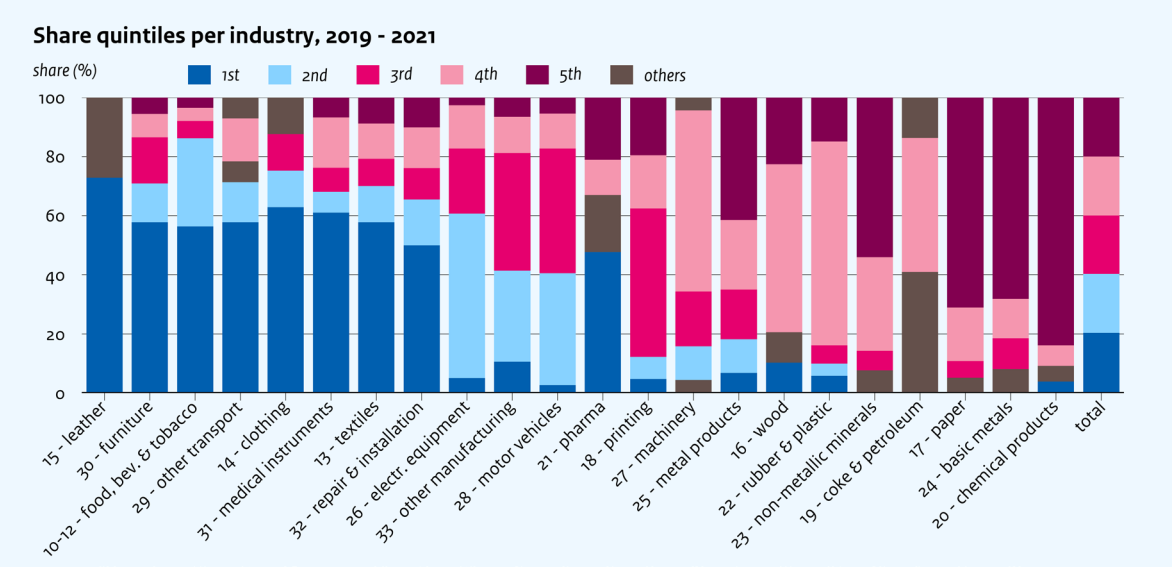
Figure 2.4 shows how each of the manufacturing industries in the Netherlands is distributed across the production chain. To create Figure 2.4, we first split all firms into five groups of equal size, based on their average upstreamness value in 2019 - 2021 (see the dotted lines in Figure 2.2). Figure 2.4 then shows what

proportion of firms in each of the manufacturing industries are in each of these five groups.4[4] For example, the dark blue bars represent the first quintile of upstreamness, i.e. the group of firms closest to the consumer. Light blue bars represent firms in the 20% of firms second closest to the consumer, and so on. For example, Figure 2.4 shows that just under 60% of firms in the furniture industry (SBI2 code: 30) are in the group closest to the consumer.

Figure 2.4 shows that firms in some industries are concentrated in one position. For example, firms in the food industries (SBI2 codes: 10-12) are mainly active in production and processing, which means that many firms in these industries operate close to the end consumer. In contrast, producers of chemical products (SBI2 code: 20) are almost all at the beginning of production processes, which means that very few firms in that industry sell products to end users, and most firms sell products to other firms as intermediate inputs.

At the same time, firms in other industries are more dispersed throughout the production process. An example of this is the production of electronic and electrical equipment (SBI2 code: 26), where a significant number of firms are active in three different positions of the production process. Within this industry, firms perform various activities, ranging from research and development (upstream) to assembly and distribution (downstream). Firms within the same industry can therefore differ greatly in their production processes and the types of goods they produce. A special case is the pharmaceutical industry, which shows a dichotomy: some firms are active close to the consumer, while others are active at the beginning of the value chain. This variation within industries can actually be positive. A diversity of business activities within an industry can contribute to a more resilient economy, because industries can better adapt to changes in market conditions and production processes.

Figure 2.4 Share of firms per industry and position in the value chain



Note: This figure shows the distribution of value chain positions (upstreamness) by industry, defined here as two-digit SBI codes, the standard industry classification of Statistics Netherlands (CBS). For each firm, we calculate the average upstreamness (2019-2021) and divide the firms into five equally sized groups (quintiles). Dark blue (1st) represents the 20% of firms with the lowest upstreamness, or closest to the consumer. Industries on the x-axis are sorted by their average upstreamness, with the leftmost industry (15 - Leather) having the lowest average upstreamness. Due to a small sample size, some subgroups cannot be exported from the CBS microdata, these are marked as "others". These areas are purely visual and do not contain any actual data, except that together they add up to the allocated area in the graph. For example, in industry 15 - Leather, groups 2-5 together account for approximately 25-30%, but the graph contains no further information on the distribution between these groups.

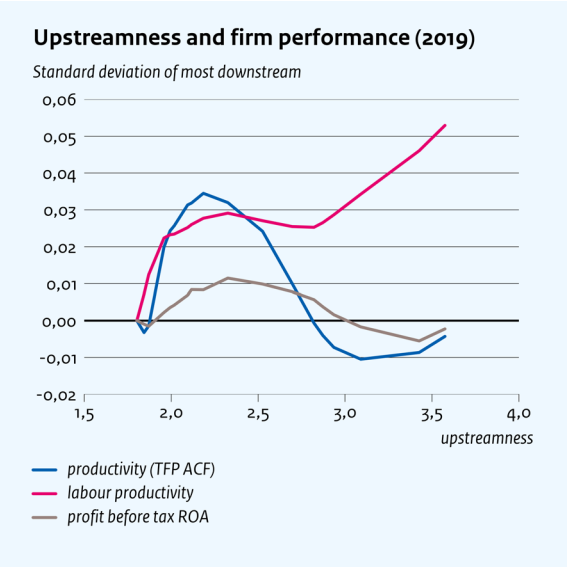
[4] We define industries here based on their two-digit SBI code (Standard Industrial Classification), the standard classification used by Statistics Netherlands (CBS). Our sample includes all SBI codes between 10 and 33. Sectors 10, 11, and 12 have been combined to allow results to be presented at this level of aggregation.

2.2 Performance of firms along the production chains

Firms at the beginning of the chain have higher labour productivity, but also higher capital use. Figure 2.5 shows that when productivity is measured as labour productivity, firms at the beginning of the chain appear to have the highest productivity on average. This seems logical at first glance, as firms in this segment often perform specialized and knowledge-intensive activities that generate high output per employee. At the same time, we see that firms at the beginning of the value chain make particularly intensive use of capital (e.g. machinery), see Figure 2.3.

When productivity is measured by total factor productivity (TFP), some firms in the middle to the end of the value chain are more productive. While labour productivity measures a firm's output taking into account the amount of labour used, total factor productivity measures a firm's output taking into account both labour and capital. Figure 2.3 shows that the median of firms in the middle to the end of the production process (around position 2.2) have a slightly higher TFP than the median of firms at the beginning or end. We also find a large number of firms in this position, and a large variance in TFP. The patterns we find for productivity may be related to the way firms use capital. At the beginning of the chain, there is a lot of investment in technology, R&D and other capital-intensive means of production. Although this increases labour productivity, it can also lead to lower TFP if the additional investment in capital does not result proportionally in more production. At the end of the chain, where firms focus on large-scale assembly and final production, capital intensity is also high, but here too this is not necessarily accompanied by a higher productivity. In the middle of the value chain is the group of firms with the lowest capital intensity, which can contribute to finding higher TFP here.

Figure 2.5 firm performance along the value chain



Note: The lowest point on the horizontal axis is the reference, and the vertical axis shows how many standard deviations more or less the median is at other points in the value chain in comparison. The figure goes from left (low upstreamness, i.e. close to the end user) to right (high upstreamness, several production steps removed from the end user).

Like productivity, profitability does not show a clear pattern through the value chain (see also the appendix). Figure 2.5 shows profit before tax divided by total fixed assets (profit before tax ROA). This means that firms at the beginning, middle and end of the chain show variable levels of profitability, with no clear trend related to their position in the chain. This suggests that profitability is not primarily determined by where a firm is in the value chain, but that other factors are more important.

3 Foreign investment and productivity

Foreign investment (FDI – to foreign direct investments) enable firms to position themselves in influence global value chains by investing in production facilities, R&D centres or distribution channels abroad. This can lead to a shift to upstream activities (e.g. R&D), a strengthening of the existing market position or an expansion to downstream activities such as distribution. Research by Statistics Netherlands (CBS) in this chapter analyses how FDI contributes to productivity growth and the competitiveness of Dutch firms. It examines whether productivity differences are not only the result of self-selection – with only the most productive firms expanding internationally – but also whether foreign investment itself contributes to productivity improvements through economies of scale and innovation.

Furthermore, it examines differences between horizontal and vertical FDI, intra- and extra-EU and between firms with different starting levels in terms of productivity. This study estimates the effects of outward FDI on productivity from a production function. This takes into account the possibility that more productive firms engage in more FDI (self-selection). Furthermore, the method takes into account the endogeneity of FDI and choices regarding the use of labour and capital. For a full description, see Appendix C2. FDI and productivity method.

Our findings indicate that, after correcting for self-selection, Dutch firms experience on average 1.8% annual productivity gains by investing abroad. We find strong heterogeneity across industries and types of FDI. First, the productivity effect is not statistically significant across industries. When it is significant, it tends to be largest in services, followed by manufacturing and then trade. Second, these effects are somewhat stronger for investments outside the EU than within the EU (between 0.1 and 0.5 percentage points more, depending on the specification) and more pronounced for horizontal FDI than for vertical FDI (up to 0.6 percentage points more). We also find that firms with lower initial productivity learn more, which can be explained by a catch-up effect. Together, these results suggest that outward FDI is a channel for productivity growth, particularly for firms expanding into distant markets.

3.1 Descriptive statistics

In this section we will show productivity differences between firms that do and do not engage in FDI. We will also look at the development within firms over time in relation to starting to invest abroad.

The share of firms engaged in FDI increased between 2010 and 2015 and thereafter stabilized. First, Table 3.1 shows the total number of firms in our dataset, the distribution across industries, and the percentage of firms engaged in FDI per year. These are firms with 10 or more employees. In 2010, of the 30,184 firms, approximately 20% were active in the manufacturing industry, approximately 15% in construction, and approximately 30% in trade and services. Over the period under consideration, the percentage of firms in manufacturing and trade is stable. The percentage of firms in construction decreases from 16% in 2010 to 13% in 2019, which coincides with an increase in firms in the service industry from 26% in 2010 to 32% in 2019. Of all firms in the sample, approximately 11% were engaged in FDI in 2010. This percentage increases over the years to approximately 16% in 2015 and remains more or less stable thereafter. A more detailed description of the data used can be found in the appendix.

Table 3.1 Numbers of firms, industries and investments

	Firms	% in manufacturing	% in construction industry	% in trade	% in services	% with FDI
2010	29,756	20.1%	20.9%	33.4%	25.6%	11.3%
2011	30,786	20.4%	20.3%	33.4%	25.9%	12.8%
2012	30,879	20.6%	19.3%	33.6%	26.6%	14.2%
2013	30,417	20.6%	18.1%	34.1%	27.2%	15.1%
2014	30,126	20.7%	17.2%	33.8%	28.3%	15.4%
2015	30,266	20.6%	16.7%	33.5%	29.1%	15.8%
2016	31,451	20.3%	16.4%	33.5%	29.7%	16.2%
2017	32,999	20.0%	16.3%	33.1%	30.6%	16.2%
2018	33,979	19.7%	16.4%	32.8%	31.2%	16.0%
2019	34,988	19.6%	16.1%	32.4%	31.9%	15.8%
total	315,647	20.2%	17.7%	33.3%	28.7%	15.0%

Internationally active firms are consistently the most productive firms. See Table 3.2, which summarizes average TFP by firm type. Here, TFP is estimated using the ACF method (Ackerberg et al., 2015). Furthermore, firms are generally more productive when they are exporters, and are most productive when they have invested. This confirms the typical sorting order found in the literature for Dutch firms (see the appendix for a review of the literature). The remainder of this article will investigate whether the higher performance of these international firms is (solely) caused by self-selection or whether a learning channel is also present.

Table 3.2 Average TFP by firm type

Never export or FDI	25 140
	[30 805]
exporter	29 732
	[220 384]
FDI	37 220
	[873]
exporter and FDI	39 995
	[63 582]

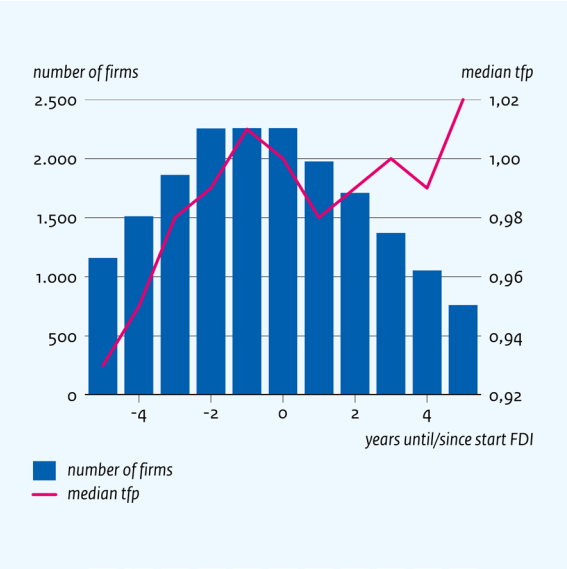
Note: A cell contains the average TFP by export/FDI status in the first line (euro per combined unit of capital and labour). In the second line and between brackets we give the number of firms per cell. Export here refers only to goods.

In addition to these differences between firms, it is also informative to look at differences within firms over time. That is, how does the productivity of firms change when they start FDI? We do this by mapping the average TFP of firms that start investing in year 0. Figure 3.1 tracks TFP in the years relative to the FDI start. It begins five years before the FDI start and records TFP until five years after (where firms may not be present in all years due to entry and exit).

We see that starting to invest abroad is associated with an initial 2% decline in TFP in the first year after FDI. However, TFP recovers rapidly in 2 and 3 to reach the level of Overall, Figure 3.1 provides evidence 0. for an initial decline, followed by a rapid recovery and ultimately positive effects of starting to invest abroad on intra- firm TFP growth. What is also interesting to note is the build-up of TFP in the years preceding the foreign

investment.

Figure 3.1 TFP development of a starting investor



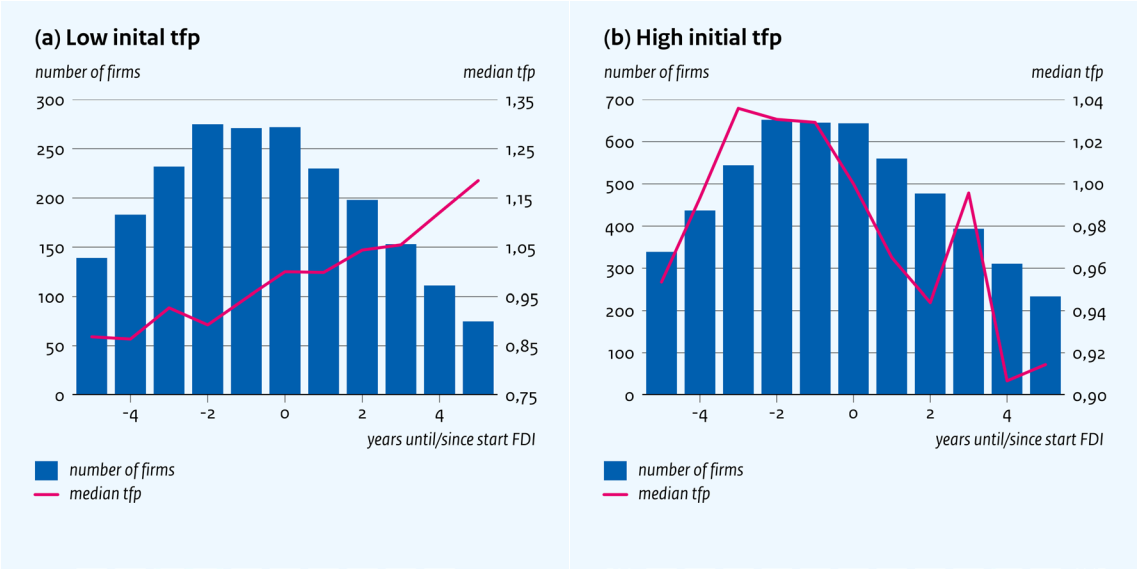
Note: We normalize the TFP within a firm by setting it to 1 in to. We then take the median of the normalized TFP for each year relative to the start of the investment. The red line and the second y-axis describe the resulting TFP index. The bars and the first y-axis show the number of underlying firms per year relative to the start of the investment.

Initially low- and high-productive firms develop differently after FDI. Figure 3.2. Panel (a) contains the start- ups with a low initial TFP, and panel (b) contains start-ups with a high initial TFP. We consider a firm to have high initial TFP if its average TFP in the years preceding the start of FDI is equal to or greater than the 75th percentile of the TFP distribution within its industry. Firms with low initial productivity have an average prior productivity that is lower than or equal to the 25th percentile. We assign all other FDI starters to the group with average initial TFP.

Panel (a) provides a clear picture that starting to invest abroad is associated with subsequent TFP growth for firms with initially low productivity. Before firms with low initial TFP invest, they already show an upward trend in their TFP. After the start of investment in t_0, in which we normalize TFP to 1 within the firm, there is a further increase in TFP in all subsequent years. Five years after the FDI start, firms with initially low productivity experienced an increase of almost 20% in their TFP compared to the TFP in t_0.

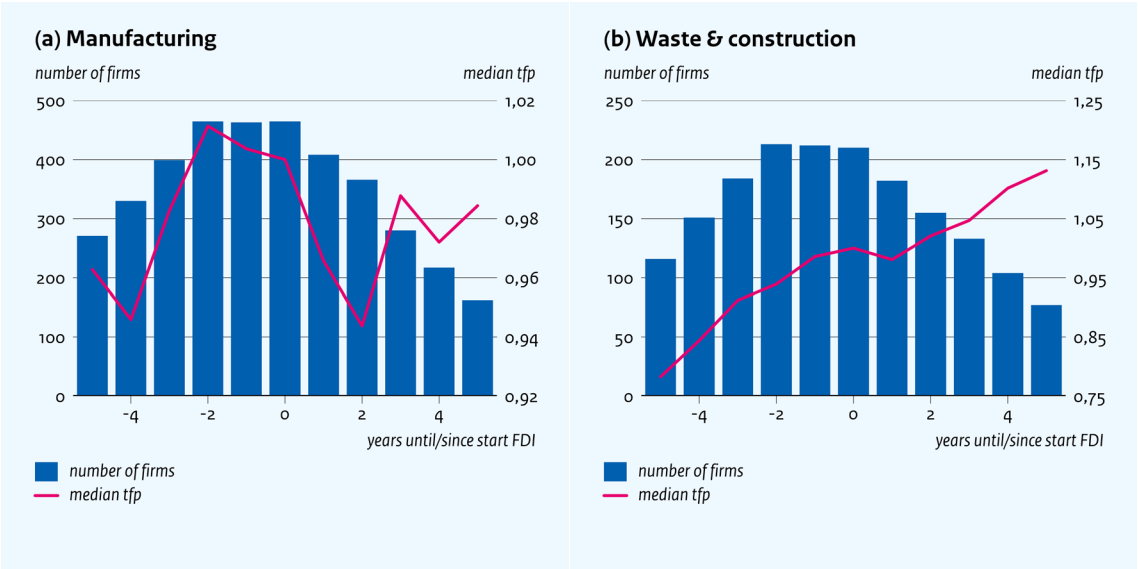
Panel (b) reveals an opposite effect for firms with initially high output. In the first two years after the investment, this group of firms experiences a decline in TFP. Strikingly, after four years, TFP has declined by almost 10% compared to t_0. Although more in-depth research is needed to observed decline, this descriptive picture suggests that low-productivity firms have more to gain from FDI than high-productivity firms. Firms with initially lower productivity can benefit more from participating in foreign markets, because they have room to learn (Lileeva & Trefler (2010).

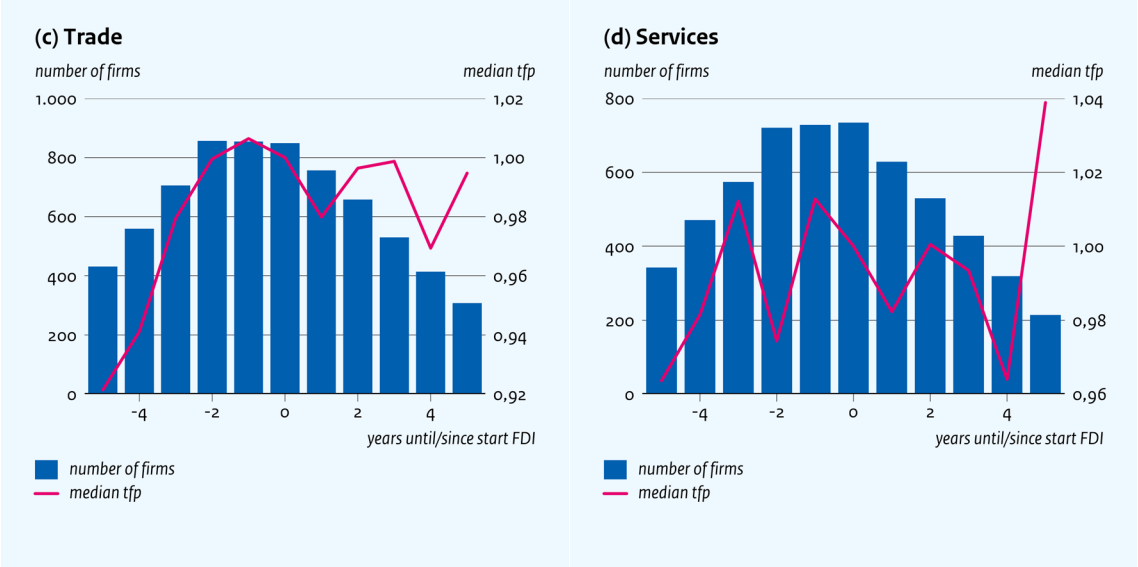
Figure 3.2 TFP development of a starting investor, per initial TFP



Finally, to gain an initial understanding of the role that industrial differences play in the relationship between FDI and productivity, we present results by industry. See Figure 3.3. We distinguish between four major industries, which are aggregations of SBI sections: manufacturing, construction, trade, and services. After the FDI entry, we observe a brief decline in TFP across all industries. Following this initial drop, TFP fluctuates around the initial TFP level. The companies that benefit most from starting to invest are in the construction industry, where TFP has increased by approximately 12% five years after the initial investment.

Figure 3.3 TFP development of a starting investor, per industry





3.2 Effect of outward FDI on firm productivity

In what follows, we will first analyse the overall effect of outward FDI on firms' productivity. We then contrast the effects of intra- versus extra-EU FDI and, for a smaller sample of firms, horizontal versus vertical FDI. Finally, we analyse the heterogeneity across firms in the productivity effects of FDI.

In the majority of industries, there is a significant productivity gain after FDI. As is common in the literature, we will loosely call the productivity gain associated with FDI the "learning effect". Table 3.3 shows the main results of the application of our basic model, per industry. We see that 20 out of 26 industries, representing 89% of the observations, experience a significant learning effect from FDI.

An investment abroad increases the productivity level of the following year by 1.8%. This learning effect varies from 1% in wholesale trade (46) to almost 6% in "Other professional services" (80-82, see figure 3.4). Service industries (from SBI 58) have a higher learning effect on average, followed by the Food industry and Other industry (SBI 10-12; 31-33) and trade (SBI 45-47). Because wholesale trade is by far the largest industry (in terms of number of firms) with a relatively low learning effect (1%), this has a downward effect on the overall average, which goes from 1.77% for all industries to 1.92% if we exclude wholesale trade. If we only look at industries with a significant learning effect, the average is 2.06% (figure 3.4). Alternatively, assigning a value of 0 to industries with insignificant learning outcomes brings the weighted average to 1.84% (Table 3.3). In terms of significance and direction of effect, this confirms the findings in Aktaÿ et al. (2024) and Damijan and Decramer (2014), while in terms of magnitude, our estimated effect lies in between.

Table 3.3 Main results of the basic estimate by industry

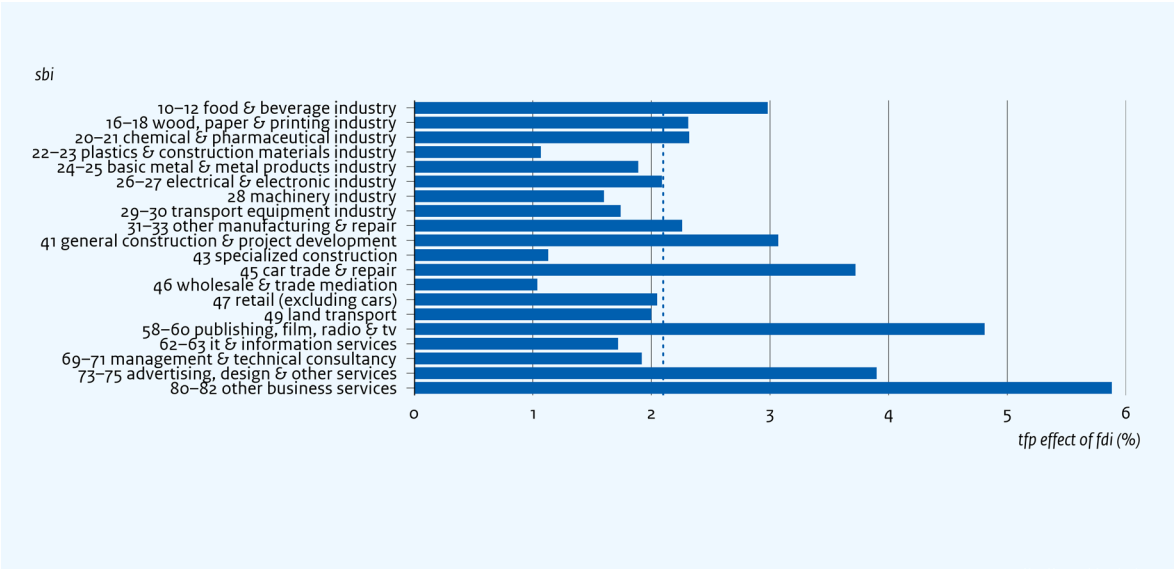
SBI Code	Description	TFP Effect of FDI	p-value	Rho	n (sample size)	% FDI Firms	% Start Events
10–12	Food & Beverage Industry	2.98%	0.00	0.89	7,928	21%	0.5%
13–15	Textile, Clothing & Leather Industry	1.13%	0.18	0.93	2	27%	0.7%
16–18	Wood, Paper & Printing Industry	2.31%	0.00	0.81	7,35	13%	0.4%
20–21	Chemical & Pharmaceutical Industry	2.32%	0.00	0.90	3,199	45%	0.8%

22–23	Plastics & Construction Materials Industry	1.07%	0.02	0.82	5,832	31%	0.7%
24–25	Basic Metal & Metal Products Industry	1.89%	0.00	0.71	15,398	16%	0.5%
26–27	Electrical & Electronic Industry	2.09%	0.00	0.80	4,383	32%	0.6%
28	Machinery Industry	1.60%	0.00	0.79	8,392	31%	1.0%
29–30	Transport Equipment Industry	1.74%	0.04	0.75	2,832	24%	0.5%
31–33	Other Manufacturing & Repair	2.26%	0.00	0.82	9,832	14%	0.5%
41	General Construction & Project Development	3.07%	0.00	0.86	14,109	5%	0.3%
42	Civil Engineering (Ground, Water, Road)	1.16%	0.17	0.85	4,004	13%	0.5%
43	Specialized Construction	1.13%	0.01	0.84	29,529	5%	0.3%
45	Car Trade & Repair	3.72%	0.00	0.81	15,13	7%	0.3%
46	Wholesale & Trade Mediation	1.04%	0.00	0.92	67,947	24%	0.9%
47	Retail (excluding Cars)	2.05%	0.00	0.84	31,483	5%	0.2%
49	Land Transport	2.00%	0.00	0.79	16,423	12%	0.5%
52	Storage & Transport Services	-0.18%	0.64	0.91	6,984	31%	1.1%
55	Accommodation Services	0.91%	0.43	0.85	5,106	5%	0.2%
56	Food & Drink Services	-2.28%	0.12	0.85	17,451	1%	0.1%
58–60	Publishing, Film, Radio & TV	4.81%	0.00	0.80	2,988	18%	0.9%
62–63	IT & Information Services	1.72%	0.00	0.85	20,971	17%	1.1%
69–71	Management & Technical Consultancy	1.92%	0.00	0.77	22,384	8%	0.5%
72	Research	-2.08%	0.50	0.97	1,845	25%	1.4%
73–75	Advertising, Design & Other Services	3.90%	0.00	0.75	9,727	11%	0.8%
80–82	Other Business Services	5.88%	0.00	0.75	11,995	5%	0.3%
Weighted Averages (n-weighted):							
All industries: 1.75% TFP effect, Rho: 0.84, n = 27,117, 20% FDI, 1% start events							
All industries excluding 46: 1.92%							
Only industries with significant TFP effects: 2.06%							
All industries, assigning zero TFP effect to insignificant ones: 1.84%							

Industries differ in the number of firms engaging in FDI. Table 3.3 shows that FDI is most prevalent in industry 20-21 (chemicals and pharmaceuticals), with 45% of all observations involving one firm, while the average FDI involvement across all industries is 20%. In the services industries, this share is much lower, with several industries having only 5% or less of firms engaging in FDI. Perhaps the relatively low prevalence of FDI can partly explain why there are larger learning effects in the services industry, as it may give those firms that do successfully engage in FDI a relatively strong comparative advantage compared to the majority that do not. Alternatively, when outward FDI in the services industry is more difficult, costly, or risky,

firms may be less likely to engage in it, and when they do, they may demand higher returns. At this stage, however, we leave the testing of these hypotheses for further research.

Figure 3.4 TFP effect of FDI, per industry



Note: The dotted line indicates the average learning effect for the industries listed above. For the full industry names, see Table C.1.

In the long term, this effect accumulates to 11.1%. The dynamic specification of the productivity process implies that the learning effect builds up over time due to the persistence of productivity. This results in a total effect of 11.1% (1.77 / (1 - 0.84)), assuming a firm continues to engage in FDI.

Industries differ in the proportion of firms engaging in FDI. Table 3.3 shows that FDI is most prevalent in industry 20–21 (chemical and pharmaceutical industry), where 45% of all observations involve FDI, while the average FDI involvement across all industries is 20%. In the service industries, this share is much lower, with several industries having only 5% or fewer firms engaged in FDI. This relatively low prevalence of FDI may partly explain why the learning effects are larger in the service industry, as firms that do succeed in engaging in FDI may gain a relatively strong comparative advantage over the majority that do not. Alternatively, if outward FDI is more difficult, costly, or risky in the service industry, firms may be less inclined to pursue it, and when they do, they may demand a higher return. At this stage, however, testing these hypotheses is left for future research.

3.3 FDI characteristics

We now zoom in on different types of FDI. We first separate FDI by destination (intra vs. extra-EU) by including an indicator for both types simultaneously in our model (see equation 3 in appendix). Overall, Table 3.4 shows slightly higher learning effects of extra-EU FDI (EEU) compared to intra-EU (IEU). The average estimated learning effect of IEU FDI is 1.2 percent, while for EEU FDI it is 1.4 percent. When we exclude the relatively large wholesale trade (46), this difference becomes clearer (1.4% for intra-EU FDI and 1.7% for extra-EU FDI). Although the learning effect is somewhat lower for intra-EU FDI, it is more often significant than for extra-EU FDI. This could be due to the fact that there is a significantly lower number of firms investing outside the EU than within the EU, as shown in the last two columns of Table 3.4.

Intra-EU FDI is more likely to have a significant effect, but investments outside the EU yield larger productivity gains on average, which may indicate higher risks and expected returns. Figure 3.5 provides a

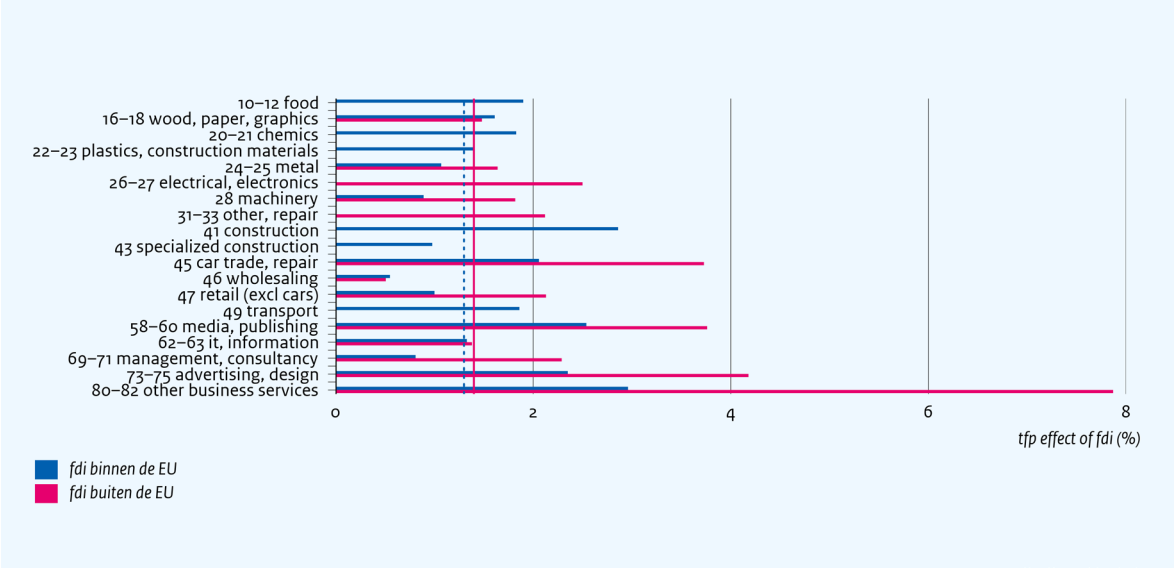
graphical summary of the results, for industries where FDI has a significant effect (and where we set the effect to zero when either type is not significant). The effect of intra-EU FDI is significantly more often significant, but almost without exception the extra-EU effect is larger in cases where it is significant. Overall, this suggests that it is either harder to invest in more distant destinations but at the same time more rewarding in terms of productivity gains, or that firms demand a higher expected return up front and only take this step if the odds are good.

Table 3.4 TFP effects of intra-EU (IEU) and extra-EU (EEU) FDI by industry

SBI	Description	TFP effect EU FDI	p-value EU	TFP effect non-EU FDI	p-value non-EU	n	% EU FDI	% non-EU FDI
10-12	Food & Beverage Industry	1,9	0	0,68	0,33	8794	17%	10%
13-15	Textile, Clothing & Leather Industry	-0,02	0,99	0,2	0,86	2210	22%	14%
16-18	Wood, Paper & Printing Industry	1,61	0,01	1,48	0,09	8071	11%	6%
20-21	Chemical & Pharmaceutical Industry	1,83	0,02	0,99	0,23	3495	36%	28%
22-23	Plastics & Construction Materials Industry	1,41	0,01	0,51	0,44	6468	26%	15%
24-25	Basic Metal & Metal Products Industry	1,07	0,03	1,64	0,01	17104	13%	8%
26-27	Electrical & Electronic Industry	0,18	0,82	2,5	0	4826	25%	20%
28	Machinery Industry	0,89	0,07	1,82	0	9204	22%	19%
29-30	Transport Equipment Industry	1,1	0,35	0,55	0,68	3122	19%	14%
31-33	Other Manufacturing & Repair	0,57	0,33	2,12	0,01	10947	11%	6%
41	General Construction & Project Development	2,86	0	1,63	0,28	15580	4%	2%
42	Ground, Water & Road Construction	-0,32	0,72	1,81	0,2	4410	12%	4%
43	Specialized Construction	0,98	0,04	1,3	0,12	32644	4%	1%
45	Car Trade & Repair	2,06	0	3,73	0	16695	6%	2%
46	Wholesale & Trade Mediation	0,55	0	0,51	0,01	75222	19%	12%
47	Retail (excluding cars)	1	0,03	2,13	0	35022	4%	2%
49	Land Transport	1,86	0	0,61	0,47	18170	11%	2%
52	Storage & Transport Services	-0,35	0,4	0,62	0,23	7758	24%	14%
55	Lodging Services	4,92	0,02	-6,96	0,01	5776	4%	2%
56	Food & Beverage Services	0,75	0,74	-2,01	0,61	19950	1%	0%
58-60	Publishing, Film, Radio & TV Services	2,54	0,03	3,76	0,03	3320	15%	6%
62-63	IT & Information Services	1,33	0	1,38	0	23580	12%	9%
69-71	Management & Technical Consulting	0,81	0,01	2,29	0	25027	6%	4%
73-75	Advertising, Design & Other Services	2,35	0	4,18	0	10859	8%	5%
80-82	Other Business Services	2,96	0	7,87	0	13452	4%	2%

Weighted averages					
All industries	1,23	1,43	30224	16%	11%
All industries excl. 46	1,39	1,66			
Only industries with significant TFP effects	1,36	1,86			
All industries (non-significant effects = 0)	1,17	1,26			

Figure 3.5 TFP effect of intra- and extra-EU FDI, by industry



Note: Dotted lines indicate average learning effects for the above industries. For full industry names see Table C.1

Next, we look at whether or not the investment is in a subsidiary that is in the same industry as the Dutch parent firm. Note that firms can conduct FDI in more than one foreign subsidiary, and that there can therefore be horizontal and vertical investments at the same time. We can only perform this exercise for firms for which we have information on the industry classification of the subsidiary, based on the OFATS data. This is a considerably smaller sample of the data and only for subsidiaries outside the EU. These results are therefore more likely to be affected by selectivity, making it more difficult to establish clear and generalizable effects. Furthermore, we exclude service industries from this analysis, where vertical FDI is rare.[5]

Horizontal FDI more often leads to productivity gains, but when vertical FDI has an effect, the impact is usually larger. Table 3.5 shows that the average productivity effects of horizontal FDI are generally somewhat larger than those of vertical FDI. Figure 3.6 shows the learning effects for industries where at least one of the forms is significant (and assigns a zero to the corresponding non-significant FDI activity). We then clearly see that horizontal FDI more often leads to productivity improvements. However, when we find a significant productivity effect of vertical FDI, it is generally larger than that of horizontal FDI. This is also true for the largest industry in terms of number of firms (Wholesale, SBI 46), where firms benefit more from vertical FDI (1.9%) than from horizontal FDI (1.4%).

There may be several explanations for these findings, but no definitive conclusions can be drawn on the basis of our analyses. A priori, it is to be expected that firms will be more 5 Only 0.7 percent of firms active in

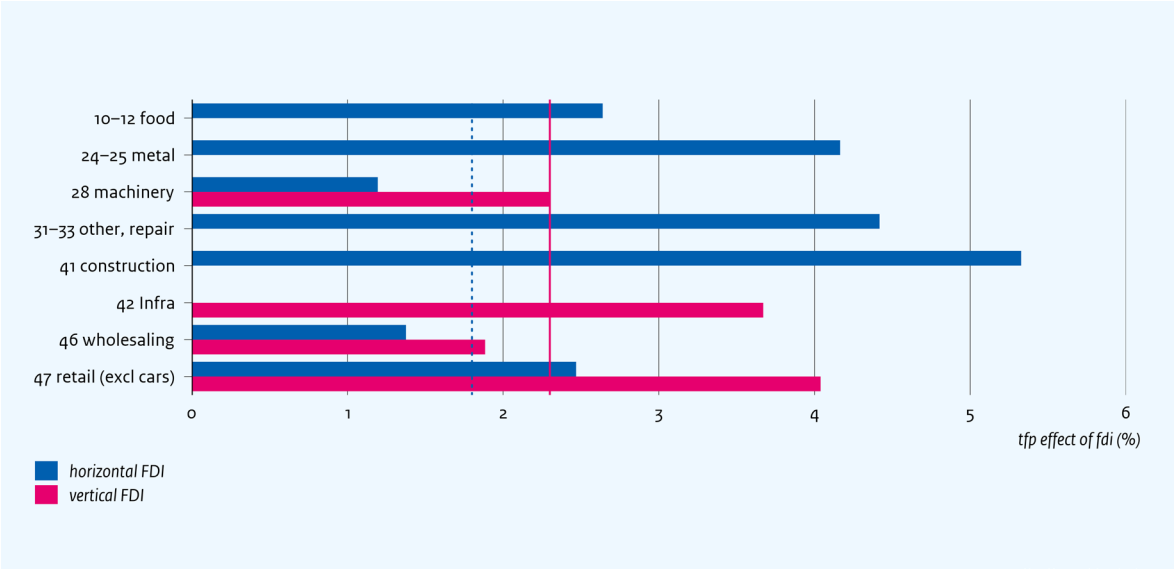
[5] Only 0.7 percent of companies active in the services sector engage in vertical FDI (VFDI). By contrast, 2.4 percent of all companies in manufacturing and trade are involved in vertical FDI—sectors that include more firms and therefore more observations in any case.

the service industry engage in VFDI. In contrast, 2.4 percent of all firms in manufacturing and trade engage in vertical FDI, which are industries with more firms and therefore observations in any case. learning from an activity that is more different from the one they are used to, i.e. from vertical rather than horizontal FDI. However, it may take more years to build up in terms of productivity improvements for the Dutch parent firm than we can observe. Moreover, the idea of absorptive capacity suggests that a firm needs to have some understanding of the processes of a foreign subsidiary in order to benefit from any knowledge spillovers (Cohen & Levinthal, 1990). Finally, it may well be that market expansion through horizontal FDI simply outweighs the productivity benefits of any type of learning or cost efficiency resulting from vertical FDI. Identifying the mechanisms that explain this pattern of differences across industries is an interesting avenue for future research.

Table 3.5 Effect of horizontal (HFDI) and vertical FDI (VFDI) on TFP

SBI	Description	TFP effect HFDI	p-value HFDI	TFP effect VFDI	p-value VFDI	n	% HFDI	% VFDI
10-12	Food and tobacco industry	2.64%	0,01	0.21%	0,87	6576	5%	3%
13-15	Textile, clothing, and leather industry	0.79%	0,58	2.59%	0,21	1656	10%	5%
16-18	Wood, paper, and printing industry	0.90%	0,59	-0.47%	0,85	6452	2%	1%
20-21	Chemical and pharmaceutical industry	-0.51%	0,69	0.84%	0,58	2009	11%	8%
22-23	Plastic and construction materials industry	-0.22%	0,89	2.62%	0,16	4240	4%	3%
24-25	Basic metal and metal products industry	4.16%	0	-0.96%	0,35	13678	3%	3%
26-27	Electrical and electronic industry	1.86%	0,14	0.65%	0,67	3453	10%	7%
28	Machinery industry	1.19%	0,1	2.30%	0,03	6704	12%	5%
29-30	Transport equipment industry	1.70%	0,38	-1.23%	0,47	2399	6%	8%
31-33	Other industries and repair	4.42%	0	0.52%	0,73	8711	2%	2%
41	General construction and project development	5.33%	0,04	1.50%	0,44	13508	1%	1%
42	Civil engineering (ground, water, road construction)	-2.41%	0,29	3.67%	0,09	3603	3%	3%
43	Specialized construction	2.45%	0,13	0.77%	0,47	28254	0%	1%
45	Car trade and repair	2.91%	0,19	3.20%	0,22	14080	1%	1%
46	Wholesale trade and trade mediation	1.38%	0	1.88%	0	54446	6%	1%
47	Retail trade (excluding cars)	2.47%	0,02	4.04%	0,01	30072	1%	0%
Weighted averages								
All industries		2.30%		1.73%		27501	6%	3%
All industries excl. 46		2.30%		1.60%				
Only industries with significant TFP effects		2.60%		2.70%				
All industries, assigning 0 to insignificant effects		1.70%						

Figure 3.6 TFP effect of horizontal and vertical FDI, by industry



Note: Dotted lines indicate average learning effects for the above industries. For full industry names see Table C.1

3.4 Firm Heterogeneity

For a more detailed picture of the productivity effects of FDI, it is interesting to see whether there is variation across firms. In the appendix we explain that this makes the model more complex. Extensive experimentation with this approach leads us to the conclusion that it is less robust in our setting. Therefore, we prefer the no-heterogeneity approach for our main results in the previous paragraphs. See Damijan and Decramer (2014) for similar considerations.[6] Nevertheless, it is insightful to discuss here the main results, which provide an indication of differences in learning effects across firms.

Table 3.6 Effect of FDI on TFP per industry (model with heterogeneity)

SBI	Description	TFP effect of FDI (avg)	TFP effect of FDI (median)	p value	n	% FDI
10-12	Food and tobacco industry	1.09%	1.16%	0	7928	21%
13-15	Textile, clothing, and leather industry	0.87%	1.37%	0,55	2000	27%
16-18	Wood, paper, and printing industry	1.69%	1.40%	0,71	7350	13%
20-21	Chemical and pharmaceutical industry	1.87%	1.95%	0	3199	45%
22-23	Plastic and building materials industry	0.35%	0.62%	0,51	5832	31%
24-25	Basic metals and metal products industry	0.99%	1.30%	0,3	15398	16%
26-27	Electrical and electronic industry	1.12%	1.12%	0,45	8392	31%
28	Machinery industry	0.84%	1.10%	0	2832	24%
29-30	Transport equipment industry	1.73%	1.16%	0,11	9832	14%

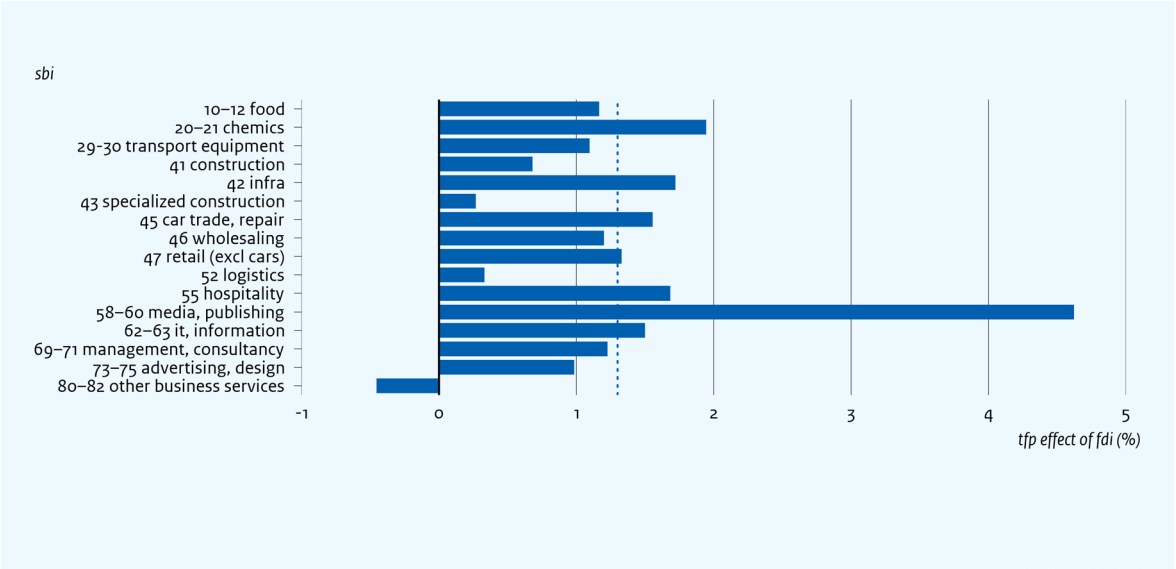
[6] We identify two industries (26–27 and 72) with implausible (i.e. negative) labour and capital coefficients using the polynomial approach. These sectors are therefore excluded from the results.

31-33	Other manufacturing and repair	2.26%	0.68%	0,02	14109	5%
41	General construction and project development	0.20%	1.72%	0,01	4004	13%
42	Ground, water, and road construction	0.56%	0.27%	0	29529	5%
43	Specialized construction	1.70%	1.56%	0	15130	7%
45	Car trade and repair	1.57%	1.20%	0	67947	24%
46	Wholesale and trade mediation	0.66%	1.33%	0	31483	5%
47	Retail trade (excl. cars)	1.10%	1.21%	0,29	16423	12%
49	Land transport	-0.39%	0.33%	0	6984	31%
52	Storage and transport services	-0.63%	1.68%	0,03	5106	5%
55	Accommodation	-26.80%	-2.41%	0,2	17451	1%
56	Food and beverage services	4.23%	4.62%	0	2988	18%
58-60	Publishing, film, radio, and TV services	1.75%	1.50%	0,01	20971	17%
62-63	IT and information services	0.98%	1.23%	0	22384	8%
69-71	Management and technical consultancy	1.25%	0.98%	0,01	9727	11%
73-75	Advertising, design, other services	-0.73%	-0.45%	0	11995	5%
All industries		1.15%	1.19%		27548	20%
All industries excl. 46		0.93%	1.19%			
Only industries with significant TFP effects		1.30%	1.27%			
All industries, with insignificant effects as 0		0.17%	0.00%			

We see fewer industries with a significant effect for the model with heterogeneity. Table 3.6 provides an overview of the results per industry. First of all, the total effect is on average much lower than in the main results (0.2% compared to 1.8% when only industries with significant learning effects are included). This may be due to the fact that this approach is more computationally intensive and requires more data. The complexity of the model may make it difficult to detect statistically significant relationships, especially in industries where FDI is less common. Figure 3.7 below shows the productivity effects for the industries where they are significant.[7] In several industries, the effect remains non-negligible. A notable difference is that the industry with the highest productivity effect of FDI in the main results (80-82: security, facility and other business services) now has the lowest and even a negative impact. For the industry with the most observations (46: wholesale trade), the effect is similar to before: 1% under the linear approach and 1.2% under the polynomial.

[7] Significance is determined based on an F-test for the joint significance of relevant terms related to FDI.

Figure 3.7 TFP effect of FDI, model with heterogeneity - by industry

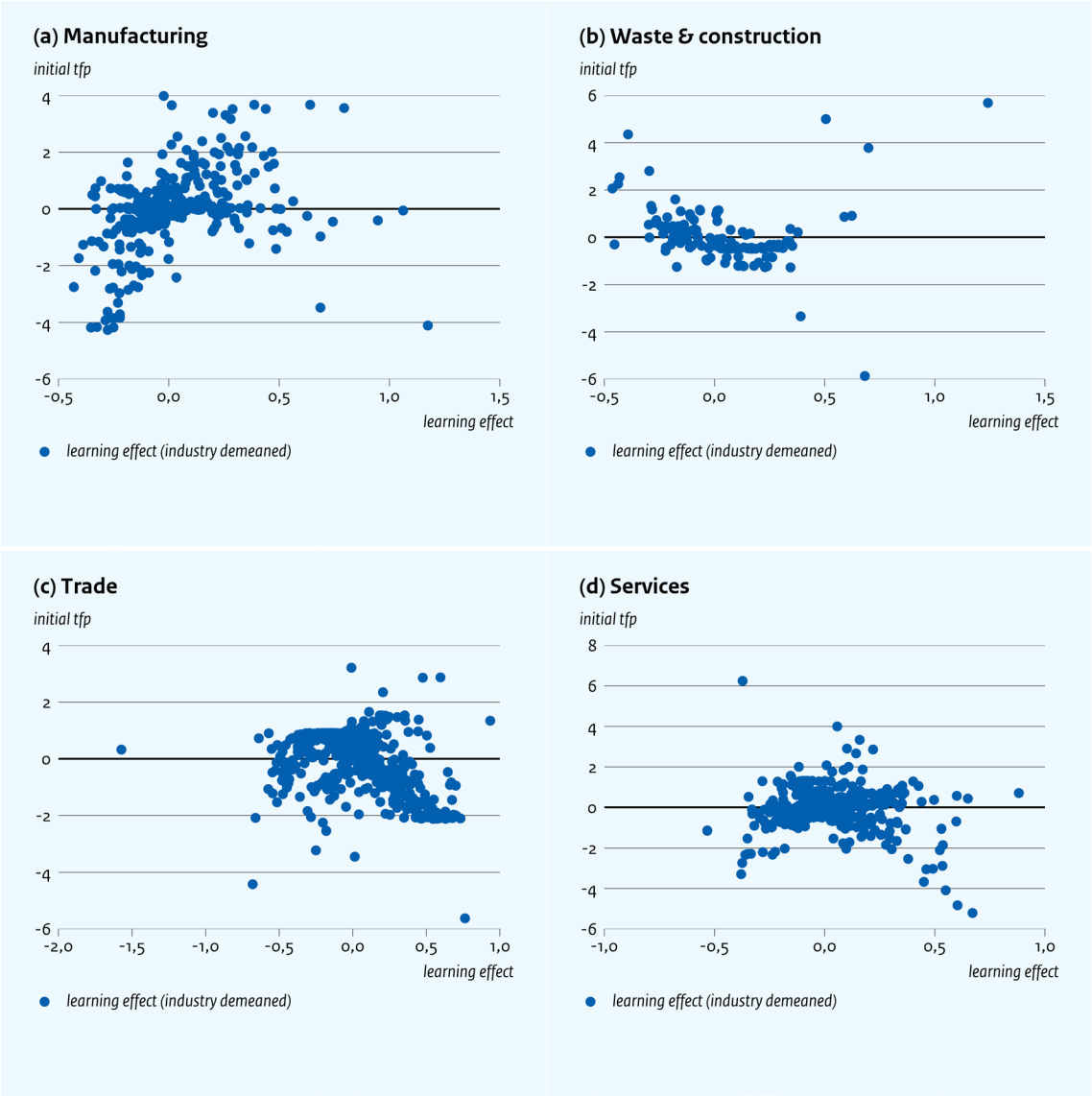


Note: dotted line indicates average learning effect for above industries. For full industry names see Table C.1

Now that we have firm-specific effects, we can further investigate the relationship between the size of the productivity effect and firms' initial productivity in the year prior to FDI. Do initially more productive firms earn more after FDI, or are less productive firms more able to catch up? We follow De Loecker (2013) by applying this approach only to observations where firms start with FDI. We see differences between industries in the relationship between learning effects and initial productivity. Figure 3.8 shows a positive correlation for manufacturing, which is in line with Damijan & Decramer (2014). However, the negative correlations in the other industries, especially the large trade industry, tip the balance for the full sample towards an overall negative trend in Figure 3.9. This suggests that initially less productive firms learn the most from investing abroad, which is consistent with the descriptive analyses reported in Section 3.

Both younger firms and exporting firms generally achieve higher productivity by investing abroad. As a final analysis, we extend the above descriptive analysis by including other firm characteristics that may influence FDI learning. We do this using a simple regression that includes, in addition to TFP, additional characteristics: the firm's age, capital intensity, whether it is owned by a foreign parent firm itself, and whether it exports. As Table 3.7 shows, only age and export status have a significant relationship with learning. Younger firms may grow faster than older firms, while firms that already export may experience complementarities between exporting and FDI. However, the main conclusion from Table 3.7 is that initial productivity is negatively correlated with learning and that this relationship is statistically significant.

Figure 3.8 Relationship between learning effects and initial TFP, by industry



Note: Both learning effects and initial TFP are industry-centric

4 Conclusion

We find no evidence that the position of Dutch manufacturing firms in the international production chain is systematically related to productivity or profitability. Although firms at the beginning of the chain have on average a higher labour productivity, these firms also use capital more intensively. If we correct for the use of capital, we see little systematic productivity differences across positions, suggesting that value creation is possible at different positions. There is some evidence that there is a group of relatively more productive firms around the middle/late stages of production (although this is accompanied by greater variation in productivity at this position). Profitability shows a flat pattern across the chain, indicating that no position is structurally more advantageous.

Dutch firms gain an average of 1.8% per year in productivity from foreign investments, after controlling for self-selection. However, there are large differences between industries and types of FDI. The productivity effect is statistically significant in most industries, but not all. In general, firms in the service industry experience the highest learning effects, followed by firms in industry and finally trade. Furthermore, the effects are larger for investments outside the EU (up to 0.6 percentage points more than investments within the EU). Horizontal FDI also appears to offer more benefits (between 0.1 and 0.5 percentage points more than vertical FDI), possibly because foreign activities are more strongly linked to domestic activities, which promotes knowledge sharing. In addition, horizontal investments can lead to market expansion and economies of scale. Firms with an initially lower productivity appear to learn more from foreign investments than firms that are already more productive, which points to a catch-up effect.

Understanding the relationship between internationalization and firm performance can help policies aimed at improving the competitiveness of Dutch firms. Our findings show that firms can actually increase their productivity through internationalization, for example by investing in foreign markets or expanding exports. This provides an important basis for strengthening policies aimed at promoting international involvement.

Since we see that internationalization improves firm performance such as productivity, policies such as trade missions, export subsidies and international trade agreements can be effective. Trade missions help firms explore new markets, export subsidies reduce the costs of doing business internationally, and trade agreements reduce trade barriers. Such initiatives can help firms reach new markets, improve their competitive position and ultimately increase their productivity. Recent research has shown that trade missions contribute significantly to the chance that Dutch firms will export with or invest abroad (Boutorat & Franssen, 2023).

Our findings do not provide clear evidence that specific parts of the production chain are inherently more productive than others. Moreover, we see considerable heterogeneity between firms within the same industry or value chain position, especially at the end of the chain. From these considerations, differences in productivity or profitability between value chain positions do not constitute a strong argument for pursuing vertical industrial policy, i.e. targeted support for specific industries or value chain positions (Advisory Council on International Affairs, 2022; Juhász et al., 2024; Liu, 2019; Vierhout et al., 2024). Instead, policymakers could consider more generic measures such as investments in education and infrastructure, predictable regulation, and promoting further market integration (horizontal industrial policy).

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Appendices

A. Literature review

Positions along the production chains

Globalization and value chains have profoundly changed production processes. The production of industrial goods has become highly globalized in recent decades (Antràs & Chor, 2022). Technological innovations in ICT and container transport have significantly reduced communication and transportation costs. Free trade agreements within the World Trade Organization (WTO) and market liberalization in countries such as China further contribute to a more integrated global economy (Baldwin, 2019). Although globalization and the expansion of value chains increased strongly until around 2010, this trend has stabilized or even declined slightly in recent years. Recent developments such as the COVID-19 pandemic and increasing geopolitical tensions are putting pressure on the growth and stability of international trade.

The literature on global value chains focuses on three main lines of research. In the literature focused on global value chains, we can roughly distinguish three main research themes: 1. the determinants of participation in value chains, 2. the effects of participation in value chains on firm outcomes, and 3. the influence of the position within the value chains on performance such as productivity, profitability and survival chances of firms. Although many studies focus on causal relationships (which can go in both directions), there are also several that investigate the relationship between value chain positions and investigate firm performance. In this paper we only analyse the relationship between value chain position and business performance of Dutch manufacturing firms, without aiming to identify a causal connection. The paper ties in with all three lines of research, with specific attention to the relationship between the value chain position and business performance of Dutch manufacturing firms.

Determinants of GVC participation can mainly be traced back to scale, location and policy environment. Firm size, geographic proximity to international markets and favourable trade and investment policies contribute to deeper GVC integration (Fernandes et al., 2022; Ignatenko et al., 2019). In addition, the presence of foreign multinationals, institutional quality and investments in technology and R&D play an important role (Urata & Baek, 2020; World Bank, 2020).

Participation in value chains is associated with higher productivity, mainly through specialization based on comparative advantage and knowledge transfer. Firms realize efficiency gains by focusing on production stages where they have a comparative advantage (Baldwin & Robert-Nicoud, 2014; Grossman & Rossi-Hansberg, 2008). Moreover, integration into value chains often leads to knowledge transfer and improved management practices, often through collaboration between multinationals and local suppliers (Ayerst et al., 2023; Banh et al., 2020; Javorcik, 2004; Merlevede & Theodorakopoulos, 2021; Rachapalli, 2021, 2024). Empirical evidence shows that firm-level GVC participation leads to higher productivity (Altomonte et al., 2018; Antràs & Chor, 2022; Banh et al., 2020; Constantinescu et al., 2019; Criscuolo & Timmis, 2018; World Bank, 2020).

The impact on employment and wages is mixed and context dependent. While GVC participation generally leads to higher productivity, the effects on labour markets are less clear-cut. They depend on factors such as relocation of production stages and capital intensity (Szymczak, 2024). Mahy et al. (2022) show that

productivity gains tend to be evenly distributed between wage increases and profits. In the Belgian institutional framework, where wages are largely centrally determined, this results in an almost equal distribution of productivity gains between labour and capital. In addition, it remains unclear to what extent participation in value chains affects the bargaining power of workers (Mahy et al., 2022).

Increasing attention is being paid to the specific position of firms within value chains. Not only participation, but also where a firm is located in the chain appears to be relevant. Previous studies introduced the measures of upstreamness (how far firms are from the end demand) and downstreamness (how close firms are to the raw materials) to describe where firms are located in the chain Antràs et al. (2012) and Chor (2019). A higher upstream position of a firm suggests the far distance to the end demand, and thus the close proximity to the raw materials.

The 'smile curve ' hypothesis states that value creation is concentrated at the beginning and end of the value chain. This idea, introduced by Shih (1996), states that both early stages of production (such as R&D, design) and late stages (such as marketing, sales) add more value than production itself. Empirical evidence for this is provided by, among others, Capello & Dellisanti (2024), Ju & Yu (2015), Mahy et al. (2022), Meng et al. (2020), Rungi & Del Prete (2018), Stöllinger (2021), and Yang & Inui (2025).
At the same time, not all literature shows unambiguous support for the smile curve. De Vries et al. (2021) argue that upstreamness shows no significant relationship with productivity or profitability. Furthermore, the authors argue for an alternative approach based on functional specialization – the actual tasks of employees – instead of just product position in the chain. Such functional specialization also shows no relationship with the upstreamness measure. Their research shows that firms focused on R&D and marketing (creative and service- oriented functions) are more productive than firms focused on manufacturing.

Empirical research partly confirms the link between chain position and firm performance. Mahy et al. (2022) finds that upstream firms in Belgium are on average more productive. Chor et al. (2021) show that productive Chinese firms become more upstream oriented as they grow, with a larger GVC span (higher upstreamness of imports and unchanged export position) in their production process. Capello & Dellisanti (2024) confirm the existence of a dynamic smile curve at the regional level in Europe: regions specialized in upstream (raw materials, R&D) or downstream (marketing) grow faster than 'factory' regions. Similar findings emerge in studies with Indian and globally operating firms, where market conditions and contractual aspects also play a role in the decision to outsource or to organize tasks in- house (Alfaro et al., 2019; Boehm & Oberfield, 2020). See Table A.1 for a short literature review on the smile curve.

Table A.1 Overview of recent literature with a focus on the smile curve

Study	Research Focus	Finding	Region/Countries	Relation to Smile Curve
Baldwin & Ito (2021)	How has value creation in export chains shifted due to globalization?	Services (R&D, marketing) play a bigger role in value creation	Global	Confirms smile curve
Capello & Dellisanti (2024)	Is regional growth related to GVC position?	Dynamic smile curve at regional level in Europe	European regions	Confirms smile curve regionally
Chor et al. (2021)	How does the GVC position of Chinese firms evolve over their life cycle and relate to firm productivity?	Productive firms shift upstream and expand production steps	China	Indirect confirmation of smile curve
de Vries et al. (2021)	Relationship between productivity and functional specialization (firm activities)	No link between upstreamness and productivity, but link with functional specialization	Netherlands	Contradicts smile curve
Mahy et al. (2022)	Effect of upstreamness on productivity and wages	Upstream firms are more productive, but linear relationship—not U-shaped	Belgium	Partial confirmation of smile curve

Meng et al. (2020)	Can the smile curve be observed at industry and country levels?	Visual confirmation of smile curve at multiple levels	China, Mexico, Japan, Germany	Confirms smile curve
Rungi & Del Prete (2018)	Where is value created within the EU production chain?	U-shaped relationship: highest value at ends of chain	European Union	Confirms smile curve
Stöllinger (2021)	Does specialization in production create less value than in pre- and post-production activities?	Countries specializing in production generate less value than those in pre- and post-production	Global, focus on EU	Confirms smile curve
Yang & Inui (2025)	How does GVC position affect trade duration and firm survival?	Upstream position increases trade duration and firm survival (better performance)	China	Indirect confirmation of smile curve

In summary, there is broad consensus that participation in value chains is an important driver of productivity and economic growth, but the impact of value chain position is nuanced and the effects on employment and wages remain uncertain. Firms can create value at different stages of the chain, depending on the industry, strategic choices, and policy climate. Although upgrading to knowledge-intensive functions often goes hand in hand with higher value creation, there is no universally optimal position. The smile curve is regularly confirmed, but the results depend strongly on measurement method and context.

Value chains, FDI and productivity

In this section, we examine the various ways in which firms participate in global value chains, with a particular focus on foreign direct investment. We also explore the motivations behind this participation and its impact on firm productivity.

Participation in the global value chain takes many forms. A value chain can be simplified and broken down into different activities that transform an input into an output (see for example Figure A.1). This chain of activities can be carried out entirely within the control of the firm and the borders of the country in which it is located. However, the firm can also choose to carry out one of these activities in another country, resulting in international, or the more popular term, global value chains (GVC). In addition to the geographical component of a value chain, a firm must also decide on the span of control it wants to maintain over all of the activities. When a firm is dependent on external firms to supply one or more of its activities, it will obviously have to trade internationally to assemble these inputs into a final product. Conversely, a firm can choose to maintain control over these activities by (partly) acquiring foreign firms, which gives it a foreign direct investor will make. The outcome of these two decisions is shown schematically in Table A.2. In this article, the focus is on the outcome in the upper right corner, namely when firms choose to outsource the production of a particular task in the value chain, but under their own control, leading to (outward) foreign direct investment.

Table A.2 Schematic overview of sourcing options

Organisation		Location	
		national *sourcing*	international *sourcing*
control	internal sourcing	national internal suppliers	international internal suppliers
	external sourcing	national external suppliers	international external suppliers

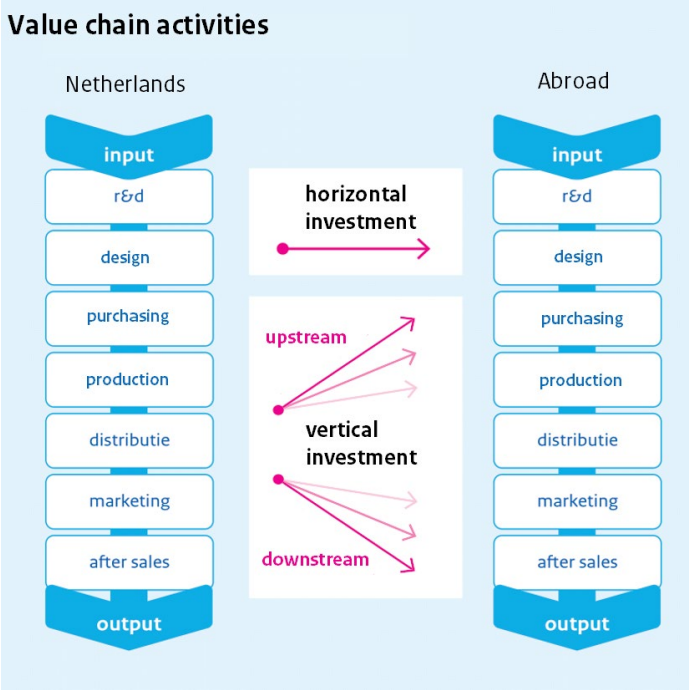
Source: Sturgeon et al. (2013)

Foreign direct investment (FDI) also comes in many forms. Depending on the position of the foreign activity in the value chain relative to domestic activities, FDI can be categorized as horizontal or vertical. In the case of horizontal FDI, a firm invests in the same activity it performs domestically. When it invests in a

different value chain activity, it is called vertical FDI. Within the category of vertical FDI, a further distinction can be made between upstream (or backward) vertical FDI and downstream (or forward) vertical FDI; related to whether the activity of the foreign subsidiary is a downstream or upstream activity with respect to the (main) activity of the investor. Typical upstream activities are R&D and design, while downstream activities include, for example, sales, distribution and marketing activities. In addition, one can think of upstream and downstream activities within the actual production phase, in particular the production of components versus their assembly into a final product (see Figure A.1).

In general, vertical investments are more typical for the manufacturing industry, while market access-motivated horizontal investments are more common in services (CBS, 2024). The share of vertical investments is relatively high in the manufacturing industry, with the share being highest in low- and high-income countries. This would suggest that for the manufacturing industry, factors such as reducing production costs, maintaining control in the chain and acquiring expertise, for example, are relatively more important drivers than, for example, gaining market access. The latter, on the other hand, seems to be an important driver for FDI in the services industry. The services industry is relatively more involved in horizontal investments, with most horizontal investments being made in high-income countries.

Figure A.1 Schematic representation of a value chain



There are different motivations behind these different forms of GVC involvement. First, the decision between relying on external suppliers or internal production can be formulated in terms of the proximity-concentration trade-off (Brainard, 1997). When a firm prefers proximity to its foreign customers and suppliers over concentrating production domestically, it will opt for FDI. Although this involves higher initial investment costs, the firm will save on variable costs in the form of trade barriers or transportation costs. Furthermore, FDI will give the firm more control over the production process, but it also entails higher coordination and transaction costs (see, for example, Antràs (2003, 2015); Baldwin, (2013)) and less flexibility given the greater commitment to the foreign market.

While these considerations apply to both horizontal and vertical FDI, there are also some specific motivations behind both forms. Horizontal FDI is typically motivated by market access, with the

aforementioned point of overcoming trade barriers being a key consideration. This allows firms to expand their customer base and potentially benefit from economies of scale. For services, this is often a sine qua non: many services can only be provided locally, requiring a commercial presence abroad. In practice, this form of service trade (known in trade statistics as Mode-3) is the largest component of world trade in services (Cernat, 2024). For vertical investments, a much-discussed reason is the reduction of production costs. Similarly, relocating part of the value chain to a country with high levels of knowledge and expertise can also be a reason for vertical investments. Given the growing importance of the knowledge economy and intangible assets, this aspect can be expected to have increased in importance (Haskel & Westlake, 2018). Control over a larger part of the value chain can be another motivation for vertical investments, where firms try to keep variable costs as low as possible by investing locally.) Finally, there can also be tax motives, for example when large multinationals open branches in countries in order to minimize their total tax burden through national and international tax rules.

In practice, all of this can come in different shapes and sizes. Sourcing decisions in a globalized world led to potentially complex global production structures (Antras, 2015). For example, a firm may perform a single value chain activity entirely in another country, other firms may choose to perform a range of activities abroad, while still other firms may perform certain value chain activities in parallel in different countries. Some firms may choose to produce abroad and then also export and distribute from the foreign location, while other firms may import the goods produced abroad and distribute them from their domestic location. In addition, there is also a distinction between full ownership of firms and partial control through joint ventures (Aktaÿ et al., 2024). Finally, a firm may establish a new firm, known as greenfield investment, or acquire an existing firm, known as brownfield.

The introduction to this article already referred to the concept of learning through internationalization – the phenomenon whereby firms increase their productivity by exporting or investing abroad. The literature has used this term in a very broad sense to refer to firms that improve their productivity by venturing abroad. The methodology we will use will also focus exclusively on improvements in (total factor) productivity (TFP). However, it is important to consider the channels and mechanisms that would actually cause this TFP growth. From the motivations of firms to engage in GVCs outlined above, we can already foresee some implications for productivity. We note that these are not exclusive to FDI but may also relate to benefits of internationalization in general.

First, there is the issue of greater market access. This is the main mechanism in the framework of (Lileeva & Trefler, 2010) through which exporting can potentially lead to productivity growth. They discuss that a larger market provides firms with greater incentives to invest in their factors of production, as there is a greater chance that these investments will yield the required returns to cover fixed costs. Exporting and (horizontal) FDI are alternative ways to gain access to foreign markets and make the associated investments that can lead to productivity growth, especially for firms in smaller markets.

The second major motivation for engaging in GVCs is to achieve cost efficiency. If a firm is indeed able to perform its tasks in the value chain more efficiently, i.e. cheaper, then this has a direct impact on its domestic productivity.

In addition to these underlying channels, learning can also occur more specifically. By coming into contact with foreign markets, suppliers, customers, rules and regulations, a firm is exposed to knowledge about different products and processes. To the extent that some of these are better than (or at least different from) the products and processes with which the firm was already familiar, this can lead to product and process innovation at home. There is a separate literature referring to learning- to-innovate-by-exporting (e.g. Silva et al. (2012) for a review of this literature).

The main conclusion of the above discussion is that GVC involvement does not always lead directly to learning per se, but that there are several underlying channels, for example increased investment, innovation or cost efficiency, which can lead to productivity improvements. In this article we will simply try to measure the latter. Although we will devote some discussion to the potential underlying channels, we do not explicitly test these potential explanations.

FDI and productivity

There are several studies showing that investors and exporters are more productive than domestically focused firms. Bernard & Jensen (2004) were the first to document this pattern for exporters, while Helpman, Melitz, and Yeaple (2004) extended this sorting by including foreign investors. They found that US investors are more productive than US traders, who in turn are more productive than purely domestically focused firms. This pattern has since been confirmed in Germany (Frey & Goldbach, 2024; Wagner, 2007, 2012), Japan (Kimura & Kiyota, 2006; Tomiura, 2007), Slovenia (Damijan et al., 2007; De Loecker, 2007, 2013), Italy (Navaretti et al., 2010), France (Hijzen et al., 2011), and the European Union as a whole (Aktaÿ et al., 2024). Conconi, Sapir and Zanardi (2016) show that Belgian firms can use exports to test a foreign market. If successful, they expand through foreign direct investment. If not, they leave the market altogether.

There are several explanations for this pattern. According to the well-known theory of Melitz (2003), especially the most productive firms succeed in expanding internationally, because they can bear the extra costs and challenges of foreign markets. Another theory states that firms actually become more productive through international activities, for example by adopting more efficient production methods. However, the evidence for this is mixed: some studies find this effect, while others show no clear relationship.

Another theory is that firms actually become more productive by being active abroad. They can learn from better technologies, more efficient suppliers or new market insights. In that case, productivity gains would only come after a firm expands internationally. However, the evidence for this is limited and studies show mixed results. Cozza et al. (2015), Li et al. (2019), Aktaÿ et al. (2024) find significant learning effects of OFDI, while Hijzen et al. (2010, 2011), Frey & Goldbach (2024), and Abdullah & Chowdhury (2020) do not. Note that both mechanisms can also coexist. For example, Hejazi & Trefler (2019) recently showed that for FDI firms, 79% of their superior performance can be attributed to self-selection and 21% to learning.

These contradictory results have led to much research focusing on better methods to measure learning effects from internationalization. Often, productivity is first calculated as total factor productivity (TFP) and then linked to internationalization, such as exports. However, this has disadvantages: it prevents learning from being measured directly and makes it difficult to attribute productivity growth to learning or self-selection. De Loecker (2013) developed a method that solves both problems and showed that Slovenian firms did indeed learn from exports. Later studies in other countries confirmed this learning effect. Manjón et al. (201 showed that Spanish firms become 4% more productive for each year they invest, while Camino-Mogro et al. (2023) showed that Ecuadorian firms gain 6-11% per year on average, depending on the specification. Benkovskis et al. (2020) show a learning effect from exports of 35-38% for Latvian and Estonian firms. They looked at different forms of involvement in the global value chain and found even higher learning effects from the export of intermediate goods, re-exports and from the export of knowledge-intensive services. Finally, Franssen et al. (2022) showed that Dutch firms learned from exports and imports through significant annual productivity growth of 4.4 and 2.2 percent.

In addition to heterogeneity in self-selection into foreign markets, there is also an ongoing debate about heterogeneous learning effects of internationalization. Lileeva & Trefler (2010) were the first to show that

firms that are initially less productive tend to learn more from export activities than firms that are more productive to begin with. They explain this by the fact that less productive firms need to make relatively larger investments to become internationally active and therefore learn more once they do so. According to them, this is also the main reason why some studies find learning effects and others do not. In particular, studies that find no effect (e.g. Bernard & Jensen, 2004) mainly look at the US, where firms have a sufficiently large domestic market to recoup the costs of the investment. As such, these firms are already more productive before they make the move to international markets. On the other hand, papers that find learning effects tend to look at smaller markets where such productivity gains have not yet been achieved domestically but were rather "forced" by foreign expansion (e.g. De Loecker, 2007, 2013; Van Biesebroeck, 2005).

The evidence for heterogeneity in the learning effects of internationalization varies across studies. Benkovskis et al. (2020) show that less productive firms learn the most from exporting, while Damijan & Decramer (2014) find the opposite for FDI. De Loecker (2013) concludes that both the least and the most productive firms benefit the most from exporting activities.

B. Data: Positions in production chains

For this analysis we use detailed CBS microdata at firm level. This dataset contains extensive information on the trade of goods of Dutch firms, whereby the trade value, the origin or destination of the goods, and the product category are registered per transaction. In addition, where possible, we distinguish between regular trade flows and re-exports, i.e. the almost direct re- export of previously imported goods.

To analyse the position of Dutch firms in global value chains, we use FIGARO, a multiregional input-output (MRIO) table (Eurostat edition 2023). This table maps the mutual relationships between industries in different countries and provides insight into how goods and services move through the chain. The method for determining the position is based on the approach of Antràs et al. (2012), in which industries are classified based on their distance to the end consumer (upstreamness). This industry information is then linked to firms' export products via a conversion table between CPA product codes and industries.

When determining the firm position, we correct for re-export: goods that are re-exported without significant processing. This correction is made at product level within a firm, so that the upstreamness score gives a more realistic picture of the actual position in the chain. This prevents firms that mainly function as a transit point from being wrongly classified as upstream.

To measure the productivity of firms, we use two measures. The first measure is labour productivity, or the added value per full-time employee (FTE, full-time equivalent). This indicates how efficiently firms use their labour. The second measure is the total factor productivity (TFP, total factor productivity) used by Statistics Netherlands (CBS) and calculated according to the method of Ackerberg et al. (2015). This measure gives an indication of the efficiency with which firms use not only labour, but also capital. In practice, the ACF method provides a better estimate of the total factor productivity (TFP) than labour productivity because the method takes into account capital and materials as input factors.

The ACF method is an improvement of previous productivity estimates. It was developed by Olley & Pakes (1996) and Levinsohn & Petrin (2003). The main goal of this method is to address endogeneity problems in the estimation of production functions. This means that the method corrects for the fact that firms decide for themselves how much input (labour, capital, and materials) to use based on their expected productivity. The ACF method uses a two-step approach with materials or investments as proxies to minimize these endogeneity problems.

Furthermore, we use average wages as a proxy for the knowledge intensity of firms. The underlying reasoning here is that higher average wages indicate a higher skill level of the employees, which gives an indication of the quality of the workforce within the firm. Finally, we use various additional measures from Statistics Netherlands at firm level. These include the age of firms, the industry in which they operate, and whether a firm is a domestic or foreign multinational. In addition, various balance sheet and income statement data are included, such as the size of the firm's balance sheet, total assets, and corporate profits. 8[8]

C. Data and method: FDI and productivity

C1. Data FDI and productivity

Sources of total factor productivity

In order to obtain the most complete picture of the productivity of Dutch firms, we combine balance sheet information from the (sample-based) Production Statistics with information from the Financial Statistics of Enterprises (NFO). In addition, these data are supplemented with tax register information (income tax, corporate tax and VAT returns). If multiple sources are available for the same firm, we use one source per year, namely the source with the largest number of years of observations. In order to cover the size classes and industries as well as possible for the analyses, we look at commercial firms in the non-financial business economy with legal personality (public limited firm and private limited firm).[9] Furthermore, only firms with 10 or more employees are included in the analysis. Finally, we only include industries with a total of at least 1000 observations. Table C.1 provides an overview of the industries in the analysis.

By combining these sources, we arrive at approximately 30 thousand firms in 2010 to 36 thousand in 2019, for which all variables are available to calculate productivity. This amounts to almost 60 thousand unique firms over the entire period 2010-2019 and thus covers the vast majority of the subpopulation examined of firms with legal personality, more than 10 employees and in the selected industries.

Table C.1 Description of the SBI codes

SBI-code	Dutch description
10-12	Food and beverage industry
13-15	Textile, clothing and leather industry
16-18	Wood, paper and printing industry
20-21	Chemical and pharmaceutical industry
22-23	Plastics and building materials industry
24-25	Basic metal and metal products industry
26-27	Electrical and electronic industry
28	Machinery industry
29-30	Transport equipment industry
31-33	Other manufacturing and repair
41	General construction and project development
42	Civil engineering (ground, water and road construction)

[8] The balance sheet data and the income statements of firms are observed at the level of enterprise groups. That is, at a higher level of aggregation than the rest of the data. This means that it is possible that some firms are assigned the same balance sheet values if they belong to the same group. However, this is rare.

[9] We also exclude the petroleum industry (NACE code 19), the real estate industry (77) and employment agencies (78), because measuring productivity is difficult here.

43	Specialized construction
45	Car trade and repair
46	Wholesale and commercial mediation
47	Retail trade (excluding motor vehicles)
49	Land transport
52	Storage and transport services
55	Accommodation services
56	Food and beverage services
58-60	Publishing, film, radio and television services
62-63	IT and information services
69-71	Management and technical consultancy
72	Research
73-75	Advertising, design, other services
80-82	Other business services

Business Characteristics of Business Demographic Framework (BDK)

We define the industry in which a firm operates using the two-digit code of the Standard Industrial Classification (SIC) codes, which correspond to the international two-digit ISIC coding scheme. Another property that we extract from the BDK is a categorical variable on control.

Foreign direct investment

To determine whether a Dutch firm had a foreign branch in the period 2010-2019, we use the Foreign Direct Investments (FDI) microdata set.[10] The microdata come from three main sources, namely corporate income tax returns (CIT), the Outward Foreign Affiliates Statistics (oFATS ,only branches outside the EU) and the information from the Financial Statistics of Large Enterprises (SFGO). By combining these three datasets, we get a good overview of whether a firm had a foreign branch in a given year.[11]

In addition to the information on whether a firm has a branch in a particular country, we also use information from the oFATS sample on the industry (two-digit ISIC) in which the branch is active. By comparing this with the industry in which the Dutch company operates, we can infer whether an investment is horizontal or vertical. If the first two digits of the domestic and foreign industry codes match, we classify the investment as horizontal—meaning the company conducts the same activities abroad. If the codes differ, we classify the investment as vertical.[12]

We note that this approach provides an approximation of whether an investment actually reflects horizontal or vertical integration abroad. For example, a car manufacturer investing in a bicycle manufacturer abroad would be classified as operating in a different industry than its domestic activity, but this does not represent vertical integration from a value chain perspective. Nevertheless, our proxy is common in the literature; see, for instance, Frey and Goldbach (2024). This comparison only applies to foreign affiliates in the oFATS sample, and thus only outside the EU; for companies not included in oFATS, we lack information on the industry of the foreign affiliate. We further note that when a company has multiple affiliates, it may simultaneously engage in both horizontal and vertical FDI (i.e., the classifications are not mutually exclusive).

[10] A foreign subsidiary is defined as a foreign subsidiary that is owned by more than 50%.
[11] However, gaps remain for which additional information can be derived. If foreign participation is reported for the two preceding and two following years, but missing for one or two intervening years, then those intervening years are filled in (interpolation). For the second year in the series (2011), participation is imputed if it is reported in the previous year and the two following years (or vice versa).
[12] In cases where a domestic group has more than one business unit with different industry classifications, we classify the foreign investment of each unit as horizontal when at least one domestic unit is active in the same industry as the affiliate. Vertical FDI then refers to all investments in activities in which none of the domestic units within the group are engaged.

FDI variables

By combining the above data sources, we can derive several FDI indicators. First, we observe whether a firm engages in direct FDI in the FDI data. In the entire sample, we observe approximately 9.5 thousand individual firms with a foreign subsidiary at some point during the observation period. We also define FDI starters as firms that, after two years without foreign investment, establish one or more foreign subsidiaries and maintain the investment for at least two consecutive years. Basing our definition on a four-year period is a way to deal with some of the incidental investment we see in the data.[13]

Using the information on the destination of the investment, we can also classify it as intra- EU or extra-EU. As shown in Table C.2, we see twice as many firms investing within the EU than outside it. This is consistent with trade patterns described in the gravity model literature, where the number of ties typically decreases with distance. To provide more detail on the type of foreign participation, we identify horizontal and vertical investments by comparing the industry of each domestic firm with that of its foreign affiliates. This is only possible for observations of non-EU affiliates that come from the oFATS sample, which explains the significantly lower number of firms for which we can infer this (columns 7-10, Table C.2). On the other hand, since this is a sample of firms that are more likely to engage in FDI, the percentage of firms within this sample engaging in FDI is higher than when we look at the full populations (e.g. column 1). Finally, we see a slightly higher percentage of firms that start with vertical than with horizontal FDI.

Table C.2: Overview of FDI data by source and type

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	FDI	**Intra-EU FDI**			**Extra-EU FDI**		**Horiz. FDI**		**Vert. FDI**	
	total	starters	total	starters	total	starters	total	starters	total	starters
Full population (N= 55.729)	17,1%	3,2%	17,1%	4,6%	8,6%	3,0%				
oFATS (N=3.062)							29,2%	4,8%	86,6%	5,6%

C2. FDI and productivity method

Our approach starts from the Cobb-Douglas production function 14[14]:

Equation 1

$$y_{it} = \beta_0 + \beta_k k_{it} + \beta_l l_{it} + \omega_{it} + u_{it}$$

where the output (value added) of firm i in year t (y_{it}) is explained by capital (k_{it}) and labour (l_{it}), the average productivity of all firms over time (β_0), and the deviation from that average of individual firms in individual years ($\omega_{it} + u_{it}$). All variables are expressed as natural logarithms. The two error components of the equation refer to a part known to the firm but not to the researcher (ω_{it}) and a part that was also not observed by the firm (u_{it}).

To estimate this production function, we use the "control function approach". This one is for the first introduced by Olley & Pakes (1996). This approach takes into account the endogeneity of capital and labour

[13] Although this is a well-known phenomenon in the literature (e.g. Van den Berg et al. 2022), it is less common among investors. Yet we see it in our data, although it could also be due to data limitations.

[14] It is possible to generalise this approach to more flexible functional forms, such as the translog, see for example De Loecker and Warzynski (2012).

decisions with respect to the unobserved productivity term (Ackerberg et al., 2015; Van Beveren, 2012). In addition, we adapt this approach to account for learning effects from internationalization, as suggested by De Loecker (2013). This is reflected in the description of the dynamic productivity process (first-order Markov):

Equation 2

$$\omega_{it} = g(\omega_{it-1}, z_{it-1}) + \xi_{it}$$

where ÿ1 is a vector of variables representing the status in ÿ 1 of all determinants of productivity in t . In econometric terms, can be regarded as an unexpected productivity shock to productivity in year t. This is in fact the main equation of our analysis, from which we derive the productivity effect of FDI.
Although it can take a flexible functional form, we first consider the linear approximation, represented by:

Equation 3

$$\omega_{it} = \rho\omega_{it-1} + \gamma z_{it-1} + \xi_{it}$$

Here the persistence parameter ρ is mentioned, because it determines to what extent the current productivity level is determined by the productivity in the previous period. The variable z_{it-1} describes the FDI behaviour of a firm and can be a single variable or a vector of variables. We use the indicators described in the previous section. Specifically, in addition to a simple FDI dummy defined as 1 when a firm has a foreign subsidiary in a given year, we also look at the (simultaneous) learning effects of intra- versus extra-EU FDI and of horizontal versus vertical FDI. In addition, there is the effect γ of the additional determinants. In the case of exports, De Loecker (2013) refers to as the learning-by-export parameter. In our case, we could use the term γ as *learning-by-investing* or *learning-by-FDI*. However, we will interpret this as a broader productivity effect, because learning may not be the only mechanism that can explain changes in productivity following FDI participation, in line with the multiple strategic considerations surrounding FDI.

The FDI decision in $t-1$ is uncorrelated with the unexpected productivity shock one year later (ξ_{it}). Moreover, the structure of the model implies that the historical effect of all decisions involving variables in z prior to $t-1$ is absorbed in ω_{it-1}. In our context this means that γ includes the productivity effect of investing in FDI in $t-1$. Moreover, including (lagged) productivity also controls for self-selection. To see this, note that self-selection in FDI implies that lagged FDI status is determined by lagged productivity. Thus, if only lagged FDI were included to determine the productivity process, its effect on productivity would include persistence, i.e., the effect of lagged productivity on current productivity. The first-order Markov process models this persistence explicitly and γ can therefore be seen as the productivity effect that is only derived from FDI.

Misspecification of the productivity process affects the ability to detect learning effects. This has also been argued by De Loecker (2013). If we incorrectly assume an exogenous productivity process, ignoring FDI, the productivity shock (ξ_{it}) will contain the productivity effect of FDI. The coefficient on capital and possibly labour will be biased if input decisions are correlated with FDI. In particular, if FDI is associated with investment and/or hiring, the output elasticities will be biased upwards. Without modelling FDI as part of the productivity process, any variation in productivity resulting from historical FDI is attributed to variation in inputs. For example, if productivity gains from FDI occur simultaneously with investment, this will bias the capital coefficient upwards and, as De Loecker shows, underestimate the productivity effect of FDI. The bias in the estimated productivity effect of FDI depends on the bias in the output elasticities, as well as on the extent to which FDI and input decisions are correlated.

The timing assumptions in the De Loecker approach imply that the model can be estimated using GMM techniques with the following moment constraints:

$$E\left[\xi_{it}(\beta_k, \beta_l)\begin{pmatrix} k_{it} \\ l_{it-1} \end{pmatrix}\right] = 0$$

where in each iteration (,) is obtained from the regression in equation (2).[15]

Finally, to investigate whether there is heterogeneity across firms in the FDI effects, we also approximate g with a higher order polynomial. See also De Loecker (2013). Although the linear approximation of g industry-specific productivity effects, they do not vary across individual firms. By using terms higher order and interactions between lagged TFP and FDI, the productivity effect varies across firms and years (i.e., depending on the initial TFP in the year of FDI).

C3. Limitations

Our analysis still has several limitations. In this section we discuss some of the most important ones. These can be seen as opportunities for extending and refining the existing research.

First, while our methodology allows us to determine whether firms become more productive from investing abroad, it is silent on the underlying mechanisms. In the literature review in Appendix A (Value chains, FDI and productivity) of this article, we discussed several channels through which FDI can affect productivity. A limitation of our approach is that we cannot distinguish to what extent the productivity effect is caused by international expansion alone, or via, for example, additional domestic investment or innovation. This may cause endogeneity problems if firms invest and innovate for reasons that are not directly attributable to foreign expansion. In that case, such productivity-enhancing effects will still be attributed to internationalization, resulting in an upward bias in the estimated FDI effect. By explicitly including firms' investment and innovation decisions in the analyses, a better picture can be obtained of this mechanism. This also applies to the role of other decisions around internationalization, such as exporting. Our results suggest that firms that simultaneously engage in FDI also export experience a higher productivity advantage. This complementarity could also be further analysed.

Other forms of potential endogeneity come in the form of measurement error. Measuring FDI in particular is a challenging problem. The literature review of this article outlined the many different forms that FDI can take. We reduce these different forms to simple binary variables, which do not account for different levels of ownership or different forms of acquisitions (brownfield, greenfield, M&As, joint ventures, etc.). Further research could distinguish between these forms to see if there are differences in the effects of FDI on productivity (see e.g. Aktaÿ et al. (2024) for findings on joint ventures versus fully controlled subsidiaries).

Furthermore, our analysis does not distinguish between Dutch- and foreign-owned firms. The latter group of firms is itself part of a foreign firm, i.e. the result of inward FDI. The implications of additional foreign subsidiaries for these firms are not necessarily straightforward, in the sense that investment decisions are determined by a foreign headquarters, and it is for example more likely that tax planning motives may come into play. A related measurement challenge is the fact that we only measure productivity for the domestic part of the firm. A multinational will be primarily concerned with its overall global performance and allocate resources across its business units accordingly. For example, if a firm outsources part of its production

[15] In this procedure, ω_{it} is recalculated in each iteration until convergence, using the formula $\omega_{it} = \hat{\varphi}(k_{it,} l_{it,} e_{it}) - \beta_0 - \beta_k k_{it} - \beta_l l_{it}$ where $\hat{\varphi}(k_{it,} l_{it,} e_{it})$ is a polynomial approximation of the production function, estimated once in a first step.

process abroad, this may be good for the competitiveness of the multinational as a whole, but not necessarily for all its parts separately. Future measurement initiatives could focus on capturing the full structure of multinationals, whereby productivity could be measured for all parts separately and for the total.

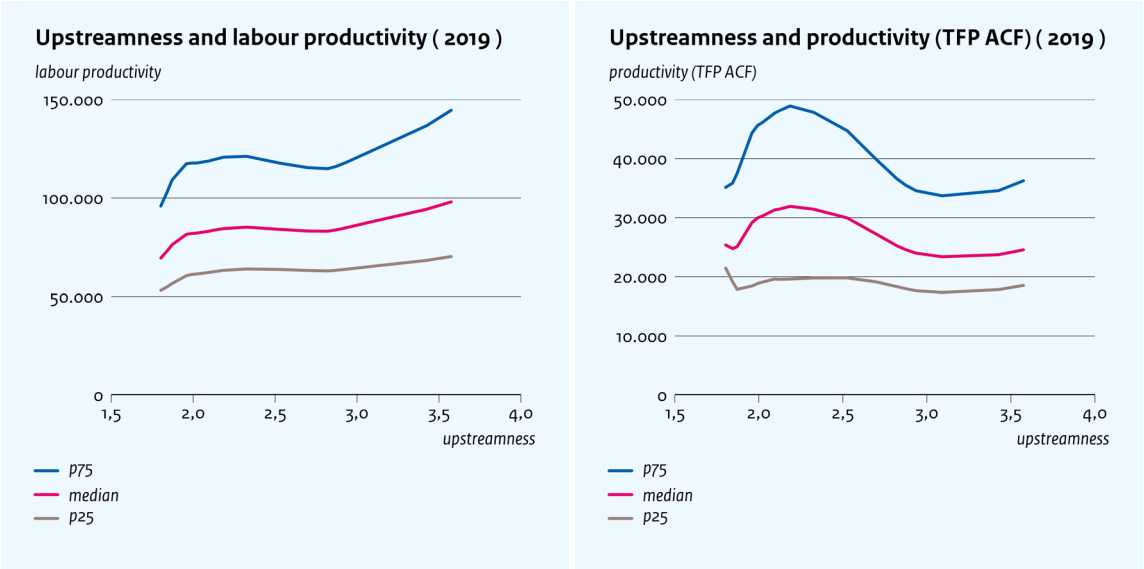
Another issue is the underlying motivations for outward FDI. Different motivations have different implications for productivity and are not homogeneous. Consider the aforementioned tax incentives, whereby multinationals can allocate investments within their corporate group, especially with regard to intellectual property. Or consider transfer pricing in the case of intra-group outward processing , whereby a firm temporarily sends intermediate goods abroad for processing, and then re-imports them. It is known that firms use existing regulations to their advantage and minimize their global effective tax burden, for example by allocating profits to jurisdictions with the most favourable tax regimes. Unfortunately, our data currently do not allow us to distinguish between affiliate and non-affiliate trade. Here too, additional data could provide a new perspective on the role of FDI.

D. Additional results: Positions in production chains

Table D.1: Descriptive statistics – Data for positions in production chains

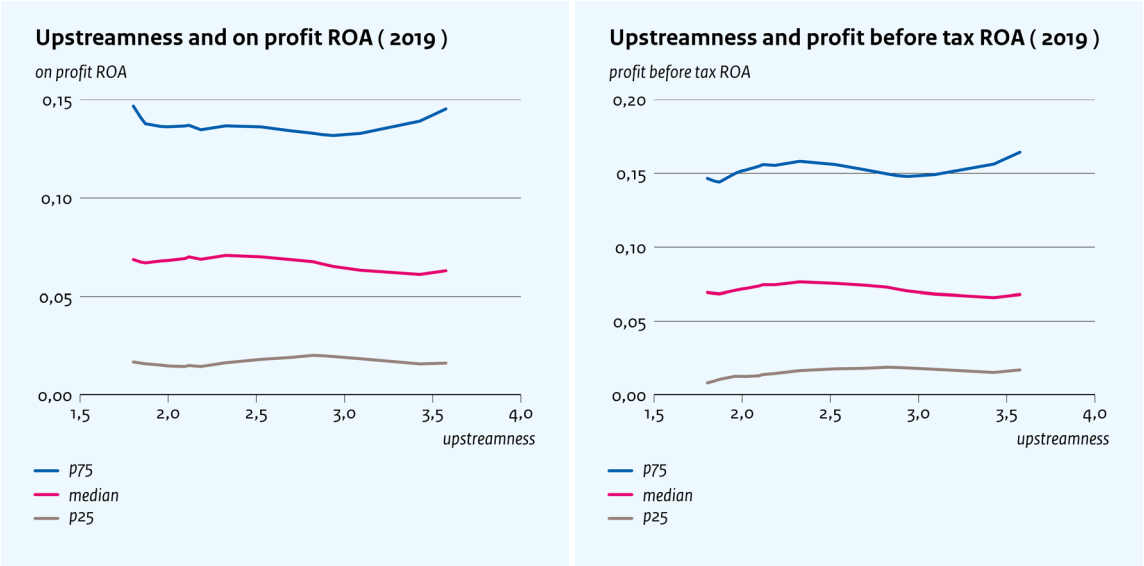
Variable	Observations	Mean	Std. Dev.
Number of firms	94,617		
Upstreamness	57,359	2.412	0.526
Total factor productivity (ACF)	56,063	34,668.8	81,234.4
Labour productivity	57,077	106	238
Capital intensity	56,886	96,432	717
Revenue	55,492	39,500,000	351,000,000
Age	94,617	21.8	17.9
Total assets	73,915	296	4,140,000
Number of employees	94,617	55.1	224.5
Foreign MNE	63,376	0.185	0.388
Dutch MNE	62,89	0.183	0.386
Profit before tax ROA	73,891	0.038	3.838
Operating profit ROA	73,891	0.048	1.068

Figuur D.1: Relationship between value chain position and labour productivity (left) and TFP ACF-method (right)



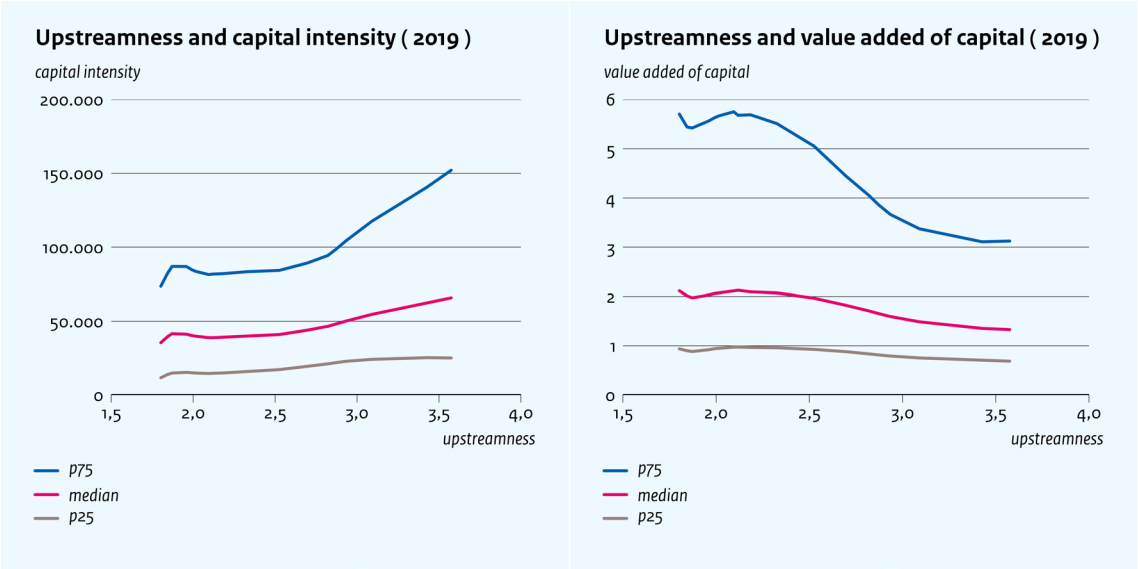
Note: All figures in this section are constructed as follows. First, we divide all firms observed in a given year into twenty equally sized groups, based on their upstreamness. For each of these groups and each y-variable (sales, labour productivity, etc.), we then calculate the median. We then use STATA's lowess command to draw a smooth line through these twenty points. We repeat the same for the 25th and 75th percentiles for each group and y-variable. Earnings ROA stands for return on assets, based on corporate profits, while PBT ROA stands for return on assets, based on pre-tax earnings.

Figure D.2: Relationship between value chain position and profit ROA (left) and PBT ROA (right)



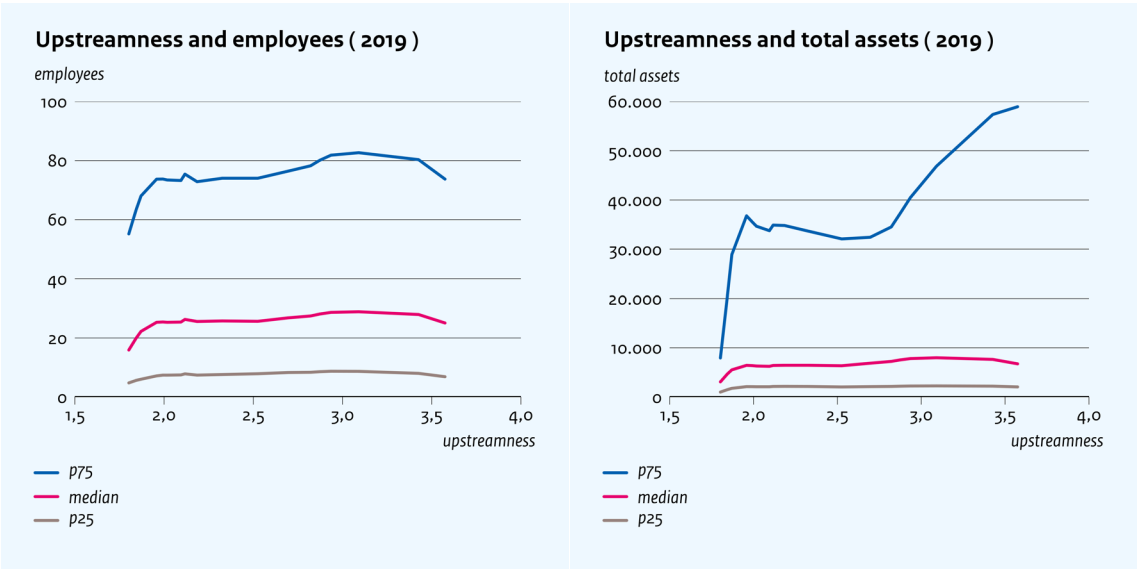
Note: All figures in this section are constructed as follows. First, we divide all firms observed in a given year into twenty equally sized groups, based on their upstreamness. For each of these groups and each y-variable (sales, labour productivity, etc.), we then calculate the median. We then use STATA's lowess command to draw a smooth line through these twenty points. We repeat the same for the 25th and 75th percentiles for each group and y-variable. Earnings ROA stands for return on assets, based on corporate profits, while PBT ROA stands for return on assets, based on pre-tax earnings.

Figure D.3: Relationship between value chain position and capital intensity (left) and added value of capital (right)



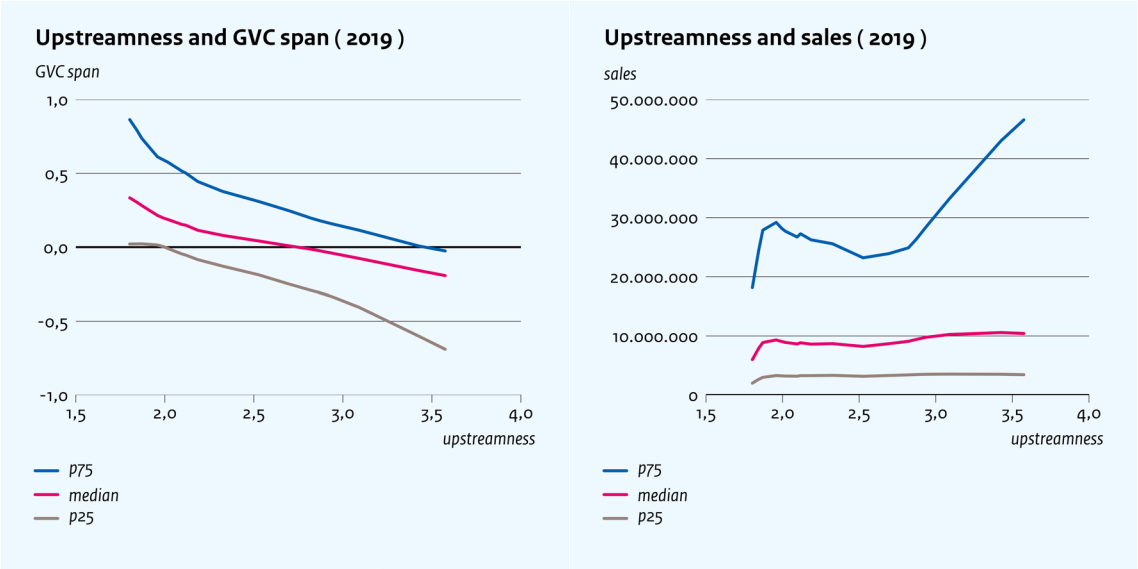
Note: All figures in this section are constructed as follows. First, we divide all firms observed in a given year into twenty equally sized groups, based on their upstreamness. For each of these groups and each y-variable (sales, labour productivity, etc.), we then calculate the median. We then use STATA's lowess command to draw a smooth line through these twenty points. We repeat the same for the 25th and 75th percentiles for each group and y-variable.

Figure D.2: Relationship value chain position and number of employees (left) and total assets (right)



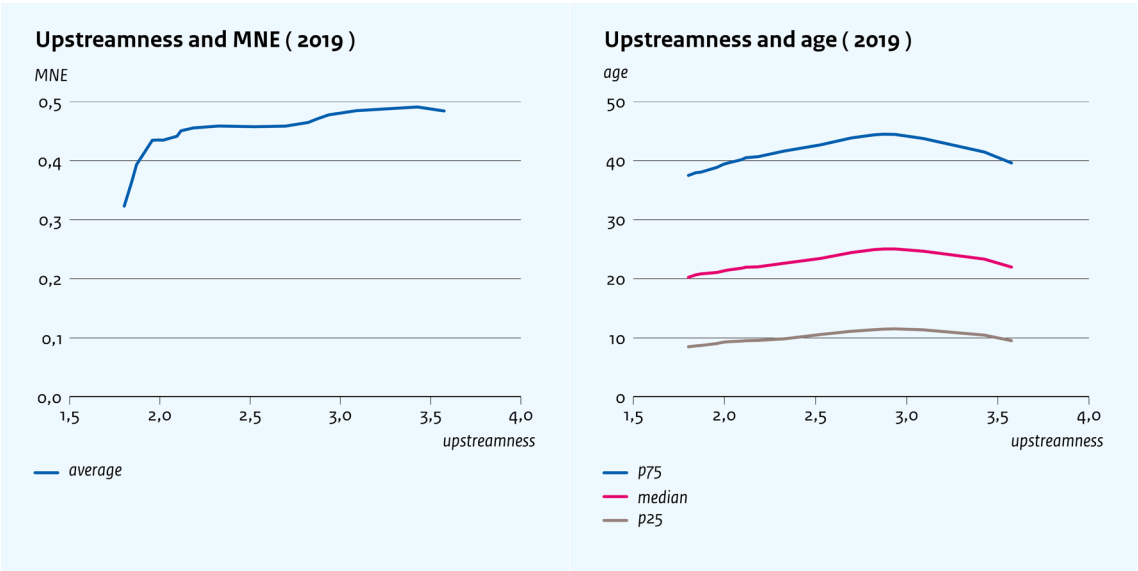
Note: This figure shows the share of individual industries within the five groups of firms along the value chain (see Figure 2.4). Groups 1 to 5 are five equally sized groups of firms, according to their average upstreamness in 2019-2021. Group 1 is the 20% of firms operating closest to the consumer (low upstreamness), etc. The data used here are for 2019-2021. We show the three largest industries within each group and aggregate the remaining industries into the 'others' category.

Figure D.3: Relationship between value chain position and GVC span (left) and sales (right)



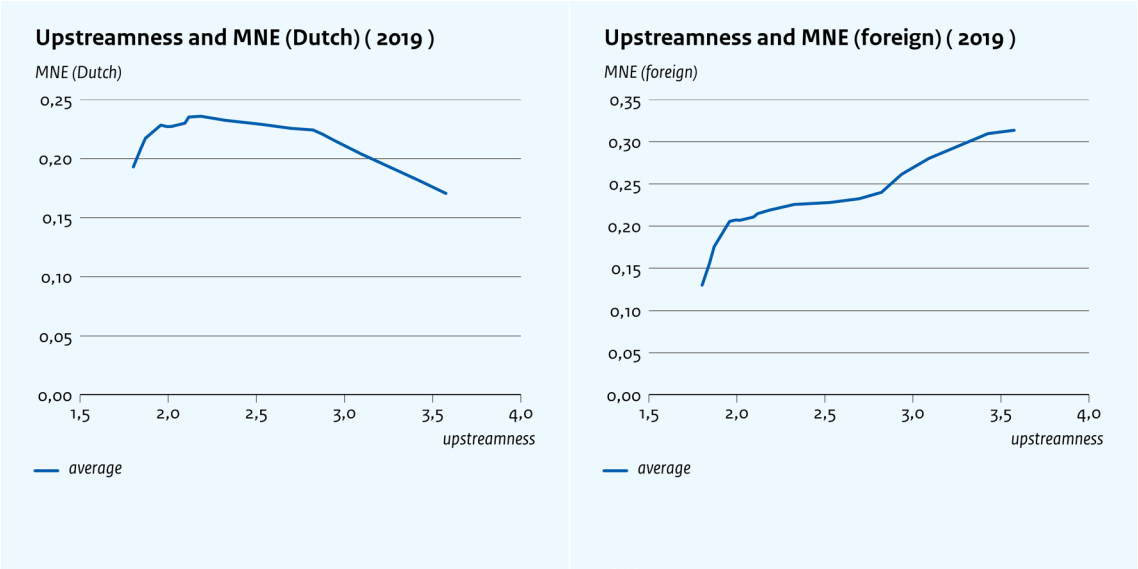
Note: This figure shows the share of individual industries within the five groups of firms along the value chain (see Figure 2.4). Groups 1 to 5 are five equally sized groups of firms, according to their average upstreamness in 2019-2021. Group 1 is the 20% of firms operating closest to the consumer (low upstreamness), etc. The data used here are for 2019-2021. We show the three largest industries within each group and aggregate the remaining industries into the 'others' category.

Figure D.4: Relationship between value chain position and multinationals (left) and age (right)



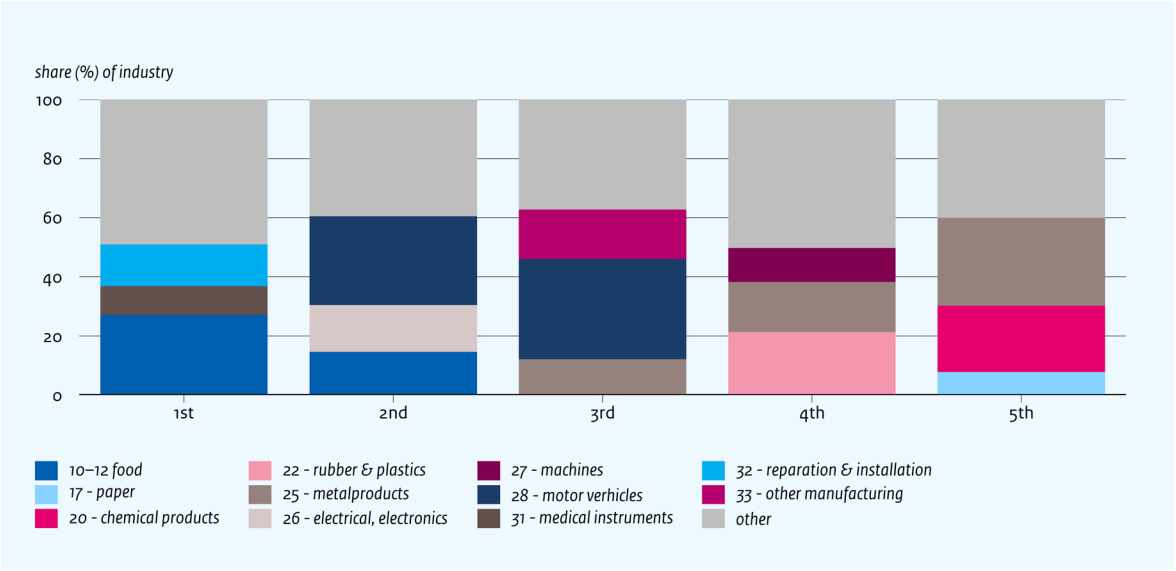
Note: This figure shows the share of individual industries within the five groups of firms along the value chain (see Figure 2.4). Groups 1 to 5 are five equally sized groups of firms, according to their average upstreamness in 2019-2021. Group 1 is the 20% of firms operating closest to the consumer (low upstreamness), etc. The data used here are for 2019-2021. We show the three largest industries within each group and aggregate the remaining industries into the 'others' category.

Figure D.5: Relationship between value chain position and Dutch multinationals (left) and foreign multinationals (right)



Note: This figure shows the share of individual industries within the five groups of firms along the value chain (see Figure 2.4). Groups 1 to 5 are five equally sized groups of firms, according to their average upstreamness in 2019-2021. Group 1 is the 20% of firms operating closest to the consumer (low upstreamness), etc. The data used here are for 2019-2021. We show the three largest industries within each group and aggregate the remaining industries into the 'others' category.

Figure D.8: Share of industries by position within production chain, 2019 – 2021



Note: This figure shows the share of individual industries within the five groups of firms along the value chain (see Figure 2.4). Groups 1 to 5 are five equally sized groups of firms, according to their average upstreamness in 2019-2021. Group 1 is the 20% of firms operating closest to the consumer (low upstreamness), etc. The data used here are for 2019-2021. We show the three largest industries within each group and aggregate the remaining industries into the 'others' category.