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Abstract

We investigate the systematic complementarities between import and export activities of firms using a novel firm-level data set for Germany. Specifically, we examine whether firms that import more are also inclined to export more, decomposing this relationship into extensive country and product as well as intensive margins of trade, with separate analyses for goods and services. By analyzing conditional correlations, the paper quantifies the role of imports in explaining exports. This complements prior studies that largely focused on either exporting or importing activities in isolation, or on specific trade liberalization episodes. We find robust evidence of import-export complementarities. Such complementarities exist for both, goods trade and, though to a lesser extent, between services trade and goods trade.

JEL-Codes: F230, F140.

Keywords: firm-level trade, margin decomposition, import-export complementarity, goods and services trade, Germany.

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1 Introduction

It is well known that a country's trade is often quite unevenly distributed across different firms. A stylized fact is that much of the overall trade is concentrated among relatively few big firms while a large group of smaller firms trade relatively little, or do not trade at all. Much less is known, however, about the extent to which this variation is due to different margins: the number of countries that firms are trading with, the number of products they are trading, or the value of their trade per country and product. Furthermore, we know little about whether firms who are strong importers are also strong exporters, i.e., on the degree of firm-level complementarity between exports and imports. Also, such complementarity between imports and exports may operate to different degrees through the various margins of exports and imports. This paper uses novel German firm-level data to address these questions.

Empirical knowledge about how firms differ on different margins of exports and imports is very important for a full understanding of world trade. Indeed, such knowledge has been an important driver for theoretical improvements regarding firm heterogeneity during the past decades, starting with the canonical model by Melitz (2003). To obtain a general view on the sources of heterogeneity across firms in German trade, we run regressions in order to decompose the observed cross-*firm* variation of imports and exports, respectively, into three components: (1) the variation in the number of countries (of destination and origin), called the extensive country margin, (2) the average number of products (exported and imported) per country, called the extensive product margin, and (3) the trade volume per country and product, called the intensive margin. Our results tell us that by far the largest share of variation is due to the intensive margin, both for exports and for imports. This seems in contrast to the findings in Bernard et al. (2009), who use the same procedure to decompose *country*-level trade flows and find that the extensive margins dominate the intensive margin, as well as in contrast to the general view, held by most empirical trade economists, that firm-level extensive margins are important channels for trade policy effects. However, we shall point out that this contrast may be explained by differing levels of analyses and definitions of the extensive product margin.

Perhaps more interesting than a mere decomposition of firm-level trade into extensive and intensive margins is the question of complementarity between different margins of exports on the one hand, and different margins of imports on the other. Recent literature has emphasized that the mechanisms behind the selection effects familiar from Melitz (2003) may generate significant within-firm complementarity such that easier or cheaper imports from some markets also boosts imports from others (Antràs et al., 2017) and may well also boost exports (Bernard et al., 2018). Complementarity may also run from easier exports to easier imports. Moreover, a positive within-firm correlation between imports and exports may indicate that firms are more tightly integrated in global value chains.

In this paper, we build on the aforementioned decomposition of imports and exports, respectively, to develop a simple regression framework that allows us to estimate the magnitudes of such complementarities within and across margins, and we apply this framework using our firm-level data set. A further emphasis of this paper lies on addressing the question of complementarity separately for trade in goods and trade in services. More specifically, we estimate coefficients measuring the magnitude of goods-to-goods complementarities as well as coefficients measuring the magnitude of services-to-goods complementarities.

We proceed in two steps. First, we run regressions explaining firm-level exports by indicator variables for imports of goods as well as for imports of services, controlling for other firm-specific effects. We find significant complementarity effects. We then estimate the explanatory power of the different margins of imports for each margin of exports. Again, we do so separately for goods and for services, controlling for other firm-specific effects. This give us a whole array of estimated complementarity coefficients, almost all of which are statistically significant.

Finally, we examine the economic significance of our results by computing the changes at the different margins of firm-level exports that follow, according to our complementarity estimates, from adding a further country of origin, or a further product to the firm's import strategy. We do so along the complete sample distributions for the extensive country and product margins of imports, again separately for goods imports and for services imports.

While the literature on firms in international trade has traditionally focused mostly on exporting (Melitz, 2003), and more recently also on importing (Antràs et al., 2017), there is little work analyzing both activities jointly. In an appendix, Antràs et al. (2017) relax the assumption that final goods are infinitely costly to trade. In this case, their model predicts a clear complementarity between both directions of trade: no matter the parametric assumptions, increasing the sourcing potential (weakly) improves the firm's exporting opportunities. On the other hand, if source countries are presumed to be complements, facilitating exports even increases firms' importing activities. Bernard et al. (2018) develop a theoretical model where firms jointly decide about their import and export behavior. They find positive correlations across the different dimensions of international activities in a year 2007 cross-section of US manufacturing firms. Similarly, in Fauth et al. (2023) we document positive correlations using a dataset that covers the universe of German firms that handle goods in the year 2019. In this paper, we go beyond the previous analysis by computing conditional correlations, exploiting the time dimension of the data, and by including trade in services. Complementarity relationships within and across extensive margins are relatively easy to explain through selection effects emphasized by Antràs et al. (2017) and Bernard et al. (2018).

Our paper contributes to the literature that explores the role of firms in global value chains. A positive complementarity within the intensive margin of imports and exports might reflect that firms are integrated into a global value chain of the 'snake' type à la Baldwin and Venables (2013). Our estimates suggest more than a mechanical relationship between imports and exports as expected for snake-like global production network. Using firm-level trade and production data, Flaaen et al. (2024) provide a micro-level analysis of global value chains running from a foreign supplier through the US to a foreign export destination, highlighting the importance of firm-level granularity that is inevitably masked during the construction of macro-level input-output tables. In essence, we take the same perspective, dissecting the margins of firms' import and export activities in goods and services in order to assess how the variation in import behavior affects their export decisions. As stressed in their paper, it is of utmost importance to conduct these analyses at the firm-level: Looking into import-export complementarity at the aggregate level might strongly underestimate the actual intensity of firms' integration into global value chains.

Antràs (2024) highlights the relevance of considering aspects of strategic behavior, both across and within firms, and especially with regard to the extensive margins. We contribute to this goal by providing a detailed margin decomposition for German firms, focusing on the interactions between different importing and exporting margins and finding substantial evidence for two-way trade complementarities. He also stresses the importance of integrating service trade into the analysis. While for instance Ariu et al. (2019, 2020) investigate complementarities between imports (resp. exports) of goods and services in Belgian firm-level data, we are – to the best of our knowledge – the first to uncover complementarities between service imports and goods exports.

While we provide a rich set of complementarity coefficients and discuss the implications of our results for the selection and snake hypotheses, earlier work has explored potential channels through which import-export complementarities work in more detail. Bas (2012) focuses on the standard channel through which importing firms' access to (cheaper, better or more varying) foreign inputs makes them more productive and thus more inclined to export. Using Argentinian data in the context of the 1991 trade reform, she shows that indeed the input-tariff cuts led firms to engage more in exporting along both the extensive and intensive margin, not vice versa. Bas and Strauss-Kahn (2014) investigate similar questions using French customs data. They find strong empirical evidence for the positive impact of access to both cheaper and better foreign inputs (from developing and developing source countries, respectively) on firms' exporting behavior. These effects occur indirectly via TFP improvements as well as directly (i.e. after controlling for productivity).

Kasahara and Lapham (2013) assume complementarity between the sunk and per-period fixed costs of exporting and importing. Using Chilean plant data, they estimate that firms who engage in both activities simultaneously can save up to 26 percent of the associated fixed costs. Gómez-Sánchez et al. (2022) investigate the impact of engaging in different trading strategies on firms' productivities, taking into account the technological regime they operate in. Using Colombian firm-level data, they find that for firms in high-tech sectors, exporting and importing facilitate each other, while in low-tech sectors and especially for smaller firms facing harsh resource constraints, firms may actually hurt themselves by taking resources off one activity to start another, implying that in these cases, importing and exporting are substitutes.

Haller (2012) uses Irish census data to analyze the behavior, characteristics and dynamics of firms that export, import, engage in intra-firm trade or pursue a mix of these strategies. She finds limited evidence for two-way trade complementarity: Two-way traders outperform pure exporters, but are on par with pure importers. In contrast, firms that import only tend to pay even higher wages than firms that both export and import. Moreover, there is evidence of strong within-group heterogeneity, which she primarily attributes to the extensive country margin. Recently, Fan et al. (2022) set up a model of multi-product exporters facing import tariff liberalization. Their model predicts – and using Chinese data they indeed find – that easier access to imports (via lower tariffs) increases exports overall and through the extensive product and country margins.

The remainder of the paper is structured as follows: Section 2 provides a short overview of the German data we employ (with detailed descriptions relegated to the appendix), while Section 3 descriptively decomposes exports and imports into their respective extensive and intensive margins. Section 4 shines a light on the complementarities between importing and exporting of goods and services, and Section 5 concludes.

2 Firm-level data

We make use of German firm-level data for the years 2011 to 2020, consisting of three primary data sets and one auxiliary data set for linking firm identifiers. The first two data sets are related to firm-level trade flows: the AFiD Panel Außenhandelsstatistik ("firm-level data panel on foreign trade statistics", short AHS) captures trade in goods, while the data set "statistics on international trade in services" (SITS)[1] provides detailed information on firm-level trade in services. Third, the AFiD-Panel Unternehmensregister ("firm-level data panel for the company register", short URS) gives us the universe of active firms in Germany, thus allowing us to account for non-trading firms. Finally, the "AFiD-Modul Combined International Trade and Investment Data" (CITID) is used to merge the service trade data with the remaining datasets.[2]

The data used in this analysis feature a number of advantageous properties: First, the data are highly granular, allowing us to distinguish German firms' exports and imports in 8-digit products or 3-digit services with specific partner countries, which in turn paves the way for the detailed margin decompositions of Section 3. Second, the data have been processed and augmented by the data-providing institutions in several ways: As laid out in Kruse et al. (2021), vigorous efforts have been made to ensure consistency and virtually full coverage of the data despite issues in the raw data related to the joint reporting of trade flows by aggregate taxable entities as well as generous reporting thresholds in intra-EU trade. Moreover, using state-of-the-art machine learning techniques, Boddin et al. (2024) have harmonized the firm identifiers underlying each individual dataset, allowing for a seamless integration and joint analysis. Third, the data is fairly recent and thus well-suited to inform current policy debates.[3]

[1]DOI: 10.12757/Bbk.SITS.01010723.07.01

[2]While AHS and URS are provided by the German Federal Statistical Office, the SITS data is collected and provided by the Deutsche Bundesbank. CITID allows us to solve the problem of different firm identifiers used by these two institutions. We do not provide DOIs for AHS, URS and CITID due to the use of project-specific data bases.

[3]While this analysis covers the time period from 2011 to 2020, DESTATIS has already announced the release of the AHS data for 2021-2023 (as of January 2025). For comparison, the recent work of Flaaen et al. (2024) still uses US data ranging from 2002 to 2017.

3 Decomposing firm-level exports and imports

Recent literature has emphasized the great variation of internationalization across trading firms. An empirical regularity often mentioned is that in almost all countries a relatively large part of all firms do not trade at all. But even among trading firms the degree of internationalization varies a lot. To what extent is this variation due to variation in the number of countries exported to, or imported from, the number of products exported or imported, or to the value of trade per destination/source country and product? In other words, what is the empirical importance of the extensive country margin, the extensive product margin, and the intensive margin in the variation of internationalization across firms?

We answer this question by means of regression analyses based on simple decompositions of firm-level exports and imports. For exports, the decomposition looks as follows:

$$X_{it} = n_{it}^{d} \cdot \bar{n}_{it}^{dp} \cdot \bar{x}_{it}, \tag{1}$$

where i and t are a firm and a time index, respectively, and n_{it}^{d} is the number of destination countries (extensive country margin), while $\bar{n}_{it}^{dp}$ is the *average* number of exported products per destination (extensive product margin), and $\bar{x}_{it}$ denotes the firm's export value per product and destination (intensive margin).[4]

The same decomposition also holds for imports, such that

$$M_{it} = n_{it}^{s} \cdot \bar{n}_{it}^{sp} \cdot \bar{m}_{it}, \tag{2}$$

where n_{it}^{s} is the number of source countries, $\bar{n}_{it}^{sp}$ is the *average* number of products per source country, and $\bar{m}_{it}^{p}$ is the firm's import value per product and source country. These decompositions can be applied to both goods and service trade, although the concept of products might be somewhat more elusive in the context of services.

The above decompositions are inspired by Bernard et al. (2009), but there are two crucial differences. The first is that we are interested in variations between firms, while they look at variations between countries of destination and origin, respectively. Accordingly, their extensive margins are the number of firms and products, respectively, rather than the number of countries and products as in our case. Perhaps more importantly, we choose a different definition of the extensive product margin. In Bernard et al. (2009), the extensive product margin is defined as the *number of distinct products traded*, regardless of how many firms actually trade a certain product with a certain country, whereas our extensive product margin is the *average number of distinct products exported per destination, or imported per source country*, calculated across all pairs of product and country.[5] They correct for the fact that not all firms are trading all goods with a certain country by introducing what they call the *density,* which is the fraction of all firm-product pairs where they observe strictly positive trade. It is relatively easy to see that the product of the extensive product margin and the density is equal to the extensive product margin as defined in our regressions.[6]

To quantify the importance of each of these margins for exports and imports, we regress each of

[4]To see that this holds, rewrite as $X_{it} = n_{it}^{d} \cdot \frac{n_{it}^{dp}}{n_{it}^{d}} \cdot \frac{X_{it}}{n_{it}^{dp}} = X_{it}$, where n_{it}^{dp} is the number of unique product-destination combinations firm i exports to at time t.

[5]In Bernard et al. (2009), if three firms each export one firm-specific product, the number of products exported is three, whereas the average number of products exported is equal to one.

[6]If f is the number of firms and p is the number of products, the density in Bernard et al. (2009) is defined as $d \equiv o/(fp)$, where o is the number of firm-product pairs with positive trade. Looking at the total value of exports per country, X, their decomposition relies on the identity $X \equiv f \cdot p \cdot d \cdot (X/o)$. Our decomposition, looking at the total value of exports per firm, $\widetilde{X}$, relies on $\widetilde{X} \equiv n \cdot \widetilde{o} \cdot (\widetilde{X}/o)$, where n is the number of destinations and $\widetilde{o}$ is the average number of goods per destination, i.e., the number of positive country-product pairs with positive trade divided by the number of countries. This latter identity may be extended to $\widetilde{X} \equiv n \cdot p \cdot (\widetilde{o}/p) \cdot (\widetilde{X}/o)$, where $\widetilde{o}/p$ is the analogue to the density as defined in Bernard et al. (2009). Thus, our extensive product margin is equivalent to the product of their extensive product margin and the density. Moving to OLS estimates of these margins, the multiplicative decomposition appears as an additive one.

the above margins on firm-level exports and firm-level imports, respectively:

$$\ln n_{it}^{d} = \alpha \ln X_{it} + \nu_i + \nu_t + \varepsilon_{it} \tag{3}$$

$$\ln \bar{n}_{it}^{dp} = \beta \ln X_{it} + \nu_i + \nu_t + \varepsilon_{it} \tag{4}$$

$$\ln \bar{x}_{it} = \gamma \ln X_{it} + \nu_i + \nu_t + \varepsilon_{it}, \tag{5}$$

where the margins are as defined above, ν_i is a firm-specific fixed effect controlling for idiosyncratic firm behavior, ν_t is a time-specific fixed effect controlling for general trends, and ε_{it} is the error term.[7] A completely analogous set of regressions is run for imports. Given that OLS is a linear estimator and its residuals have an expected value of zero, the coefficients α, β, and γ sum to unity, with each coefficient representing the share of the overall variation in firm-level exports, or firm-level imports, explained by the respective margin. The OLS estimates of these coefficients thus give an answer to the following question: If some firms export (import) more than some others, do they simply export (import) more per country and product, or do they also export to more (import from more) countries, and do they export (import) more products than other firms?

The answer is found in Table 1. By far the largest share of variation in exports, 65.9 percent, is explained by the intensive margin, i.e., the trade value per firm and product. For imports, the intensive margin contribution is even higher at 76.4 percent. By comparison, for exports the extensive country margin explains 21.4 percent of the variation while the extensive product margin explains 12.7 percent. For imports, the product margin is about equal in magnitude, 10.6 percent, while the country margin is smaller still, at 12.9 percent.

Table 1: Margin decomposition for German firm-level trade in goods

	$\ln n^d$	$\ln \bar{n}^{dp}$	$\ln \bar{x}$	$\ln n^s$	$\ln \bar{n}^{sp}$	$\ln \bar{m}$
$\ln X$	0.214***	0.127***	0.659***			
$\ln M$				0.129***	0.106***	0.764***
N	1,381,374	1,381,374	1,381,374	1,867,780	1,867,780	1,867,780

Source: Research Data Centre (RDC) of the Federal Statistical Office, project-specific data based on AFiD-Panel Außenhandelsstatistik (AHS), 2011-2020, own calculations.
Note: *** $p < 0.001$. Excludes firms engaged in intra-EU trade below the reporting thresholds; see Fauth et al. (2023). Firm and time indices i and t are suppressed for simplicity.

It is interesting to compare these results with those for the US in Bernard et al. (2009), who ask a similar question for US exports and imports, respectively. They find that the US export more to some countries than to others, not so much through all of its firms exporting more, but through a larger number of firms exporting to those countries, but also through exporting more products to these countries. In other words, the extensive firm and product margins dominate the intensive margin of exports. A similar finding emerges for variations across countries of origin for US imports. Perhaps the most interesting aspect of comparison is our low estimates for the extensive product margins for exports and imports. However, it turns out that this discrepancy is largely explained by the difference in definition of the product margin; see above. In their decomposition, almost the entire contribution of the extensive product margin is offset by a negative contribution of the density. More specifically, while variations in the number of traded goods seemingly explain above 50 percent of variation in exports across countries of destination, this explanation is mostly compensated by an offsetting variation in the density. If the extensive product margin is defined as the average number of products per firm, as in our paper, then its contribution to the variation of exports across destinations in Bernard et al. (2009) is down to less than 10 percent, and similarly for imports; this is roughly comparable to our estimates in Table 1.

In our results, both extensive margins are highly significant, though smaller than the intensive margins. Interpreted through the lens of a Melitz-type selection mechanism for differently productive

[7] In the presence of firm and year fixed effects, we can only have firms in the sample that export (or import) in at least two years.

firms, this is evidence of a fixed cost of exporting and importing, respectively, that is increasing in the number of countries traded with as well as in the number of distinct products traded.

4 Complementarities between import and export margins

4.1 Theoretical remarks

Intuitively, the trading activity of a firm in any one market is not independent of its trading activity in others. An obvious link exists in the form of imported intermediate goods or services needed to produce exported goods. This may reflect domestic firms' being integrated in *global production networks,* provided that production follows a "snake-like" pattern, as opposed to a "spider-like" pattern; see Baldwin and Venables (2013). A snake pattern of global production requires that parts need to be produced in a specific order, or sequence, with multiple shipments of half-finished goods across national borders, whereas a spider-pattern needs no specific order of production and final assembly may be a footloose activity. In this latter case a firm's contribution to global production involves an exporting activity which need not be linked to the firm's importing activity. In contrast, a snake pattern of global production does imply such a direct link, which may aptly be described as a being part of a *value chain.*

However, links of complementarity between different trading activities may also exist in more subtle ways that are related to the type of selection effects characteristic of Melitz (2003)-type models. This was first described in analytical detail by Antràs et al. (2017) who look at different import markets, or sourcing countries, for intermediate inputs. They derive conditions under which different sourcing countries are substitutes or complements, respectively. A country being a *substitute* for others means that if a firm self-selects into sourcing an input from this country, then the odds of this firm selecting inputs also from other countries become lower. The opposite holds true if the country is a complement. Complementarity arises if demand for the final good is sufficiently elastic and source countries differ a lot in terms of their productivity. Obviously, this type of complementarity reinforces the tendency of more productive firms sourcing from more countries than less productive firms, due to country-specific fixed costs.[8]

Bernard et al. (2018) extend this idea of complementarity to the relationship between import margins on the one hand, and export markets on the other. Suppose a firm with a higher elemental productivity finds it worthwhile to incur the fixed cost of increasing the number of source countries for its inputs beyond the number chosen by a less productive firm. This may reduce its marginal cost of production, say because of enhanced input variety. The lower marginal cost will then not only increase its overall sales, depending on the elasticity of demand, but may also make it worthwhile for the firm to incur the fixed cost required to start exporting, or to sell on further export markets. A similar argument applies to the number of products sold on any one market, if there are product-specific fixed selling costs.

4.2 Estimation and results

We now use the above decomposition of firm-level imports and exports to explore such firm-level complementarities between imports and exports. In a first step, we explore whether firms that import goods or services tend to have higher goods exports than other firms. We do so by regressing goods exports on two indicator variables that capture active participation in importing goods or importing services, respectively:

$$X_{it} = \exp\left(\alpha \cdot \mathbb{1}_{M_{igt}>0} + \beta \cdot \mathbb{1}_{M_{ist}>0} + \nu_i + \nu_t\right) \cdot \varepsilon_{it}, \tag{6}$$

where $\mathbb{1}_{M_{igt}>0}$ and $\mathbb{1}_{M_{ist}>0}$ are indicator functions of positive imports of goods and imports of services, respectively. Since our complete data set also contains firms that do not export, we use Poisson-Pseudo

[8] The relationship between firm-level productivity and the number of source countries is much less straightforward in the case of substitutability between source countries.

Maximum Likelihood (PPML) estimation to account for the many observations where $X_{it} = 0$.[9]

In a second step, we relate firm-level *goods exports* as well as each of the export margins considered above to the different margins of firm-level *goods imports*. To this end, we run the following set of regressions:

$$\ln Y_{igt} = \alpha \ln n^{s}_{igt} + \beta \ln \bar{n}^{sp}_{igt} + \gamma \ln \bar{m}_{igt} + \nu_i + \nu_t + \varepsilon_{it}. \tag{7}$$

In this equation, Y_{igt} stands for five different outcome variables: total exports X_{igt}, the extensive country margin of exports, n^d_{it}, the extensive product margin of exports, $\bar{n}^{dp}_{it}$, the intensive margin of exports, $\bar{x}_{it}$, and overall sales S_{igt}. The subscript g refers to goods. The explanatory variables are the number of source countries for imports, n^s_{igt}, the average number of imported products per source country, $\bar{n}^{sp}_{igt}$, and the intensive margin of imports, $\bar{m}_{igt}$. The symbols ν_i and ν_t stand for firm- and time-specific fixed effects, and ε_{it} is an error term. Given the set of fixed effects, these regressions can only be performed for firms that export and import goods in at least two time periods. We run the regressions on both 3-year interval data (2011, 2014, 2017, 2020) with contemporaneous regressors, as well as on annual data with one-year lagged regressors. Both of these estimation strategies are motivated by the gravity literature (Yotov et al. 2016). Interval data can help to reduce serial correlation in the error terms and smooths out short-term fluctuations, while using lagged regressors enables us to exploit the full data, yet controlling for the potentially dynamic relationship between importing and exporting.[10]

In a third step, we augment the above equation by additionally including the different margins of services imports:

$$\begin{aligned} \ln Y_{igt} = \alpha \ln n^{s}_{igt} + \beta \ln \bar{n}^{sp}_{igt} + \gamma \ln \bar{m}^{p}_{igt} + \delta \ln n^{s}_{ist} \\ + \zeta \ln \bar{n}^{sp}_{ist} + \eta \ln \bar{m}^{p}_{ist} + \nu_i + \nu_t + \varepsilon_{it} \end{aligned} \tag{8}$$

where subscript s refers to services. These regressions can only be performed for firms that export and import goods and services in at least two time periods, which drastically reduces the sample size. Again, we run the regressions on interval data (2011, 2014, 2017, 2020) with contemporaneous right-hand side variables and on annual data with one-year lagged right-hand side variables.

Table 2: Extensive margin indicator regression

	X
Good importer: $\mathbb{1}_{M_g>0}$	1.010***
Service importer: $\mathbb{1}_{M_s>0}$	0.178***
N	2,514,062

Source: Research Data Centre (RDC) of the Federal Statistical Office, project-specific data based on AFiD-Panel Außenhandelsstatistik (AHS), AFiD-Panel Unternehmensregister (URS) and AFiD-Modul Combined International Trade and Investment Data (CITID), 2011-2020, own calculations. Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, Statistics on International Trade in Services (SITS), 2011-2020, own calculations.
Note: *** $p < 0.001$. Excludes firms engaged in intra-EU trade below the reporting thresholds; see Fauth et al. (2023). PPML estimation. Firm and time indices i and t are suppressed for simplicity.

Table 2 presents the results for step one. The estimated coefficient for the importer-dummy for goods indicates that firms with positive imports of goods may be expected to export $[\exp(1.01) - 1] * 100 = 174.6$ percent more, in value terms, than firms with zero imports of goods, regardless of whether they import services. Likewise, the expected value of goods exports by firms with positive service imports is higher by $[\exp(0.178) - 1] * 100 = 19.5$ percent than the expected exports by firms with zero service imports, regardless of whether they import goods. This is clear evidence of complementarity between imports and exports. The coefficient for goods imports may seem surprisingly large. We should emphasize again, however, that our sample includes firms with zero exports.

[9] If firms do not show up explicitly in our goods or service trade datasets, we add zeros for them in the estimation.
[10] Coming back to our discussion of the motives behind these complementarities, it may take some time for imports to impact on firms' exporting behavior, as cost structures and pricing do not adapt instantaneously.

What is the strength of this complementarity across the above margins of exports and imports, conditional on a firm being an exporter to start with? Tables 3 and A.1 in Appendix A give the answer, presenting coefficient estimates for the above equations using data described in Section 2. Table 3 presents estimates obtained using annual data with three-year time intervals, while Table A.1 presents estimates for annual data with a one-year interval, but with a one-year lag for all explanatory variables. In contrast, the specification underlying Table 3 has contemporaneous explanatory variables. Both tables are based on OLS estimation using only observations with strictly positive trade. The top parts of each table relate to Equation (7), looking only at goods imports; the bottom parts relate to Equation (8), looking at goods imports as well as imports of goods and services.

Different regressions for goods exports and its margins as well as for sales as dependent variables are reported column-wise, while the corresponding regression coefficients for imports of goods and imports of services, with the different margins, as described in the left-most column, are listed row-wise. The regression for total exports is found in column one and the different export margins behind the total follow in columns two through four. The final column has results for an analogous regression for total sales, rather than exports. Rows one through three of either panel show coefficients for different margins of goods imports while rows four through six of the bottom panel do the same for services imports.

The overall picture is one of significant complementarity: At the firm level, importing helps for exporting. But the degree of complementarity differs substantially across different export margins and different import margins. Comparing columns, we observe that complementarity is strongest for total exports, stronger than for the different export margins. This is to be expected, since the percentage changes of $\ln n_g^d$, $\ln \bar{n}_g^{dp}$ and $\ln \bar{x}_g$ add up to the percentage change of $\ln X_g$, whence the same must hold for the coefficient estimates in each of the rows in the table. Comparing rows, i.e., looking at different import margins, complementarity is stronger for the extensive country margin, with a coefficient of 0.465 in the equation for total exports, compared to 0.237 for the extensive product margin and 0.141 for the intensive margin. The complementarity from all margins of imports is somewhat lower for total sales than for export sales.

We also see that coefficients of within-margin complementarity are generally larger than coefficients of cross-margin complementarity, as witnessed by the relatively large diagonal elements in columns 2 through 4 in rows 1 through 3 of Table 3. For instance, a one percent increase at the extensive country margin of goods imports is associated with a 0.266 percent increase at the extensive country margin of goods exports, but an increase of only about 0.1 percent at the extensive product margin and the intensive margin, respectively, of exports. In a similar vein, the 0.237 percent increase at the extensive product margin of goods exports, associated with a 1 percent increase in imports, is mainly due to the extensive product margin of goods imports (0.15 percent, compared to 0.078 percent from the extensive country margin and 0.009 percent from the intensive margin of imports).

Complementarity relationships within and across extensive margins are relatively easy to explain through selection effects as emphasized by Antràs et al. (2017) and Bernard et al. (2018), whereas a complementarity relationship within the intensive margin of exports and imports is easier to explain as reflecting the integration of firms in snake-like production networks; see above. It is therefore interesting to note that of all the estimated within-margin, goods-to-goods complementarities, the one for the intensive margin is the lowest, with a coefficient of 0.101, compared to 0.150 for the extensive product margin and 0.236 for the extensive country margin. Our results thus indicate that the complementarity between imports and exports of German firms involves more than a mechanical relationship between imports and exports as expected for snake-like global production networks.

A further interesting result is that significant complementarity also obtains between service imports and goods exports, though with lower point estimates, as evidenced in rows four through six of the bottom panel of Table 3. Only one pairwise combination of margins yields a negative coefficient: the number of imported products per country seems to have a negative effect on the average value of exports per country and product, although the coefficient is weakly significant (and even not significant at the 5 percent level in Table A.1) and only shows up when we control for service trade.[11] But the

[11]Without controlling for service trade, the coefficient is positive and small, but not significant at the 5 percent level

Table 3: Margin complementarity regressions

	Goods import margins only				
	(1)	(2)	(3)	(4)	(5)
	$\ln X_g$	$\ln n_g^d$	$\ln \bar{n}_g^{dp}$	$\ln \bar{x}_g$	$\ln S$
$\ln n_g^s$	0.465***	0.266***	0.0966***	0.103***	0.205***
$\ln \bar{n}_g^{sp}$	0.237***	0.0777***	0.150***	0.00893	0.175***
$\ln \bar{m}_g$	0.141***	0.0392***	0.000518	0.101***	0.0834***
N			313,854		589,358

	Goods and service import margins				
	(1)	(2)	(3)	(4)	(5)
	$\ln X_g$	$\ln n_g^d$	$\ln \bar{n}_g^{dp}$	$\ln \bar{x}_g$	$\ln S$
$\ln n_g^s$	0.538***	0.278***	0.174***	0.0858***	0.172***
$\ln \bar{n}_g^{sp}$	0.317***	0.117***	0.240***	-0.0401*	0.131***
$\ln \bar{m}_g$	0.204***	0.0435***	0.00515	0.155***	0.0556***
$\ln n_s^s$	0.190***	0.0751***	0.0328***	0.0824***	0.158***
$\ln \bar{n}_s^{sp}$	0.172***	0.0439***	0.0251	0.103***	0.127***
$\ln \bar{m}_s$	0.0965***	0.0104**	0.0170***	0.0692***	0.0796***
N			33,299		42,863

Source: Research Data Centre (RDC) of the Federal Statistical Office, project-specific data based on AFiD-Panel Außenhandelsstatistik (AHS), AFiD-Panel Unternehmensregister (URS) and AFiD-Modul Combined International Trade and Investment Data (CITID), 2011-2020, own calculations. Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, Statistics on International Trade in Services (SITS), 2011-2020, own calculations.
Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Excludes firms engaged in intra-EU trade below the reporting thresholds; see Fauth et al. (2023). All regressions control for firm- and year-specific fixed effects. Estimation on interval data for 2011, 2014, 2017 and 2020. Firm and time indices i and t are suppressed for simplicity.

coefficient estimates for goods-to-goods complementarity are even increased once we allow for the potential of services-to-goods complementarity. Moreover, the pattern of diagonal (within-margin) dominance relative to off-diagonal (cross-margin) complementarity remains invariant to the addition of complementarity from services imports.

Comparing the two tables for the two methods of estimation, we generally find larger coefficient estimates when using contemporaneous regressors in the three-year interval data (Table 3) than for lagged regressors in the data with a one-year interval (Table A.1). In the equation for total exports (column 1), the values for lagged data are down to almost half of the corresponding values for the contemporaneous data. The difference is somewhat less pronounced for the different margins. There are but three cases where the comparison runs into diverging results: the product margin for services imports in the equation for the product margin for exports (column 3), and for both, with and without service trade, the product margin for goods imports in the equation for the intensive margin for exports (column 4). In all cases, the coefficient estimates point in the same direction, but the statistical significance varies.

While it is reassuring that both specifications point to the same direction for all margin combinations (especially with virtually all coefficients being positive and most of them significantly so, confirming our initial suspicions derived from the theory), it also makes sense that the coefficients in Table 3 turn out larger than those for the lagged specification in Table A.1. With interval data, we smooth out potentially opposing short-time fluctuations, reduce serial correlation (which, if positive, would diminish the coefficients), and capture the cumulative effect over the entire three-year interval. Conversely, employing lagged regressors captures how the within-firm import margin variation across the previous period affects the within-firm export margin variation in the current period, which –

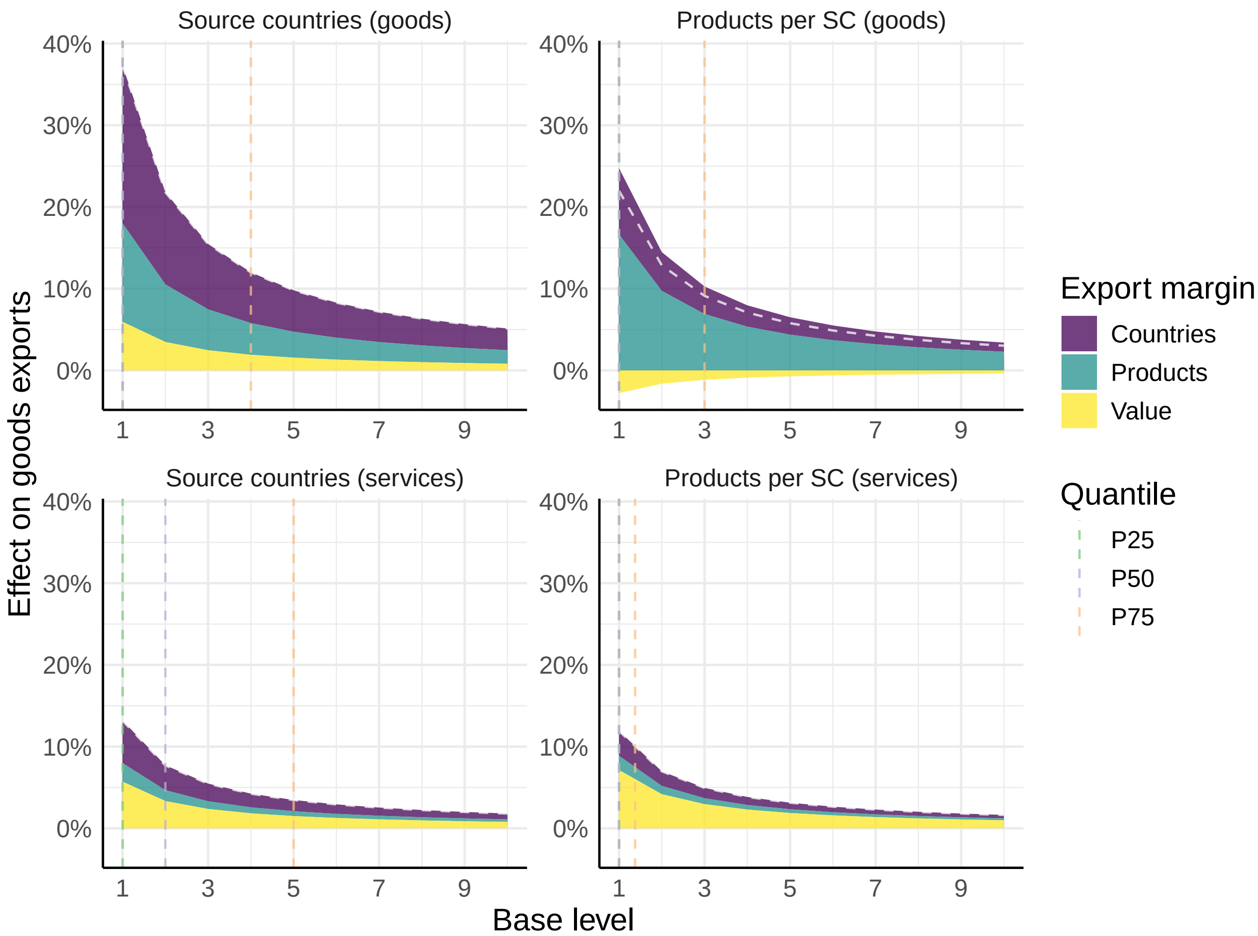
in the specification with interval data.

while relevant – might still fall short to the corresponding contemporaneous variation. Both of these characteristics should lead to smaller coefficients for the yearly lagged regressor specification. But still, in Table A.1 the coefficients are predominantly significant and exceeding a magnitude of 0.01 percent.

4.3 Economic significance

What is the *economic* significance of the complementarities evidenced by the above tables? We answer this question by using the above coefficient estimates in order to calculate the effect on firm-level exports that follow from adding one further country of origin in a firm's goods imports as well as from adding one further product to its goods imports. In each case, we calculate the log-changes $\Delta \ln n_g^s$ and $\Delta \ln \bar{n}_g^{sp}$ that are implied by $\Delta n_g^s = 1$ and $\Delta \bar{n}_g^{sp} = 1$ at various points of the respective sample distributions of these variables. We do the same for services imports. We then compute the overall effect on total exports as well as the effects on the familiar export margins according to the above coefficient estimates. To put the calculated effects into perspective, we identify the points p25, p50 and p75 in the sample distribution for the number of countries and the number of products; see Tables B.1 and B.2 in Appendix B.

Figure 1: Economic significance of estimated effects



Source: Research Data Centre (RDC) of the Federal Statistical Office, project-specific data based on AFiD-Panel Außenhandelsstatistik (AHS), AFiD-Panel Unternehmensregister (URS) and AFiD-Modul Combined International Trade and Investment Data (CITID), 2011-2020, own calculations. Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, Statistics on International Trade in Services (SITS), 2011-2020, own calculations.
Note: Total effect on goods exports is indicated by the dashed white line. Excludes firms engaged in intra-EU trade below the reporting thresholds; see Fauth et al. (2023). Effects are based on the coefficient estimates in Table 3 (contemporaneous interval data). SC refers to source country.

The results are depicted in Figure 1, based on Table 3 (contemporaneous interval data), and in

Figure A.1 in the Appendix, based on Table A.1 (lagged annual data). In each figure, the two panels in the first row show the results for goods imports while the second row shows the corresponding results for services imports. In each row, the first panel looks at the effects of adding a further source country while the second adds a further product. Remember that for each import margin the coefficients on the export margins $\ln n_g^d$, $\ln \bar{n}_g^{dp}$ and $\ln \bar{x}_g$, listed column-wise in Tables 3 and A.1, add up to the coefficient on total exports $\ln X_g$. The effects depicted in the first panel of Figure 1 are calculated as follows:

$$\Delta \ln X_g = (\hat{\alpha}_{n^d} + \hat{\alpha}_{\bar{n}^{dp}} + \hat{\alpha}_{\bar{x}}) \cdot \Delta \ln n_g^s \tag{9}$$

In this equation, $\hat{\alpha}_{n^d}$ denotes the estimated coefficient for the extensive country margin for goods imports (n_g^s) in the equation for the extensive country export margin, and analogously for the other coefficients, and $\Delta \ln n_g^s$ denotes the log-change in the number of source countries for goods imports calculated for alternative hypothetical scenarios that seem useful to judge the economic significance of the coefficient estimates. For all of these scenarios, we add one further source country but calculate the implied relative increase for alternative initial values of n_g^s that we observe in the sample distribution. Table B.1 summarizes this distribution through values at p25, p50 and p75. We follow a completely analogous procedure for the extensive product margin of imports, i.e., for $\Delta \ln n_g^p$, and for services imports; see Table B.2. In the various panels of Figure 1, the vertical axis depicts $\Delta \ln X_g$ according to the above equation as well as its decomposition into the various export margins familiar from above, and the horizontal axis depicts the initial values of various extensive country and product margins of imports. The dashed lines mark the p25, the p50 and the p75 values of the respective distributions.

Clearly, the magnitude of the effects is reduced as we move to ever larger "initial values" for our scenario of adding a further country or product to goods or services imports, respectively. For a firm located at p50, the calculated magnitude of the complementarity is quite sizable: a total export effect of more than 35 percent, almost half of which comes through an increase in the number of destination countries, with the effect through the intensive export margin being the smallest in the composition. Even at p75 of the sample distribution, adding another source country for goods imports would still increase exports by an average of 10 percent. For the extensive product import margin, the effect on exports is mostly driven by the extensive product margin, while the effect delivered through the intensive export margin is even negative. At the median, adding another 8-digit product to a firm's import portfolio increases exports by over 20 percent, which drops down to just below 10 percent at p75.

In contrast to goods imports, the complementarity effect from services imports mainly runs through a positive intensive export margin. Should the median firm add a third source country to its services imports, our calculations imply an increase in goods exports by about 7.5 percent, about half of which would run through the intensive margin. Intuitively, the extensive product export margin plays only a small role: due to the broad definition of service categories, the variation along this dimension is limited, with even the firm at the 99th percentile merely exporting 3.33 service "products" per destination. While the overall effect on exports is almost identical when we instead vary the number of imported service types, the weights of the involved margins shift even more towards the intensive margin.

Given the smaller coefficient estimates in Table A.1, we should also expect smaller economic effect magnitudes in Figure A.1. And indeed, the overall effects on exports decrease by roughly 40 percent when comparing each panel to the corresponding panels in Figure 1. Nonetheless, even at p75 of each margin's sample distribution, the effect of increasing the extensive margins by one country or product per country still amount to approximately 10 percent in three out of four cases, the only exception being the number of source countries for service imports (4 percent).

5 Conclusion

This paper uses a novel firm-level data set to decompose the variance of export as well as import activity across German firms into the variance at an extensive country margin, an extensive product margin, and an intensive margin. We find that the intensive margin variation contributes far more to the overall variation of exports and imports, respectively, than the two extensive margins. We may conclude that if some German firms export more than others it is not so much because they export to more countries, or export more products, but because they simple export more per product and country of destination. This holds analogously for imports.

The paper exploits the same data set in order to estimate a whole array of coefficients that quantify different channels of complementarity between the import activity of German firms on the one hand, and the export activity on the other. Our estimated coefficients point to a significant degree of complementarity: in the cross-section of firms, strong importers also tend to be strong exporters. Such complementarities may exist due to firms being embedded in certain types of global production networks, but also due to mechanisms of self-selection among heterogeneous firms. Estimating coefficients of complementarity between and across different import and export margins allows us to portray a rich and differentiated picture of complementarity. Our findings highlight the significant role that imports play in explaining exports of German firms, complementing prior studies that often analyzed these activities in isolation or focused on specific trade liberalization episodes. Moreover, our estimation results provide suggestive evidence that self-selection mechanisms are more important channels of complementarity than participation of German firms in global production networks.

We also disentangle goods-to-goods complementarities from service-to-goods complementarity between imports and exports. The latter are somewhat lower in magnitude, but still statistically significant. Examining economic significance, we find that adding a further source country to a firm's goods imports is associated with an increase in the firm's overall value of goods exports of up to 40 percent. Doing the same for the firm's services imports is associated with an overall increase in goods exports of up to 10 percent.

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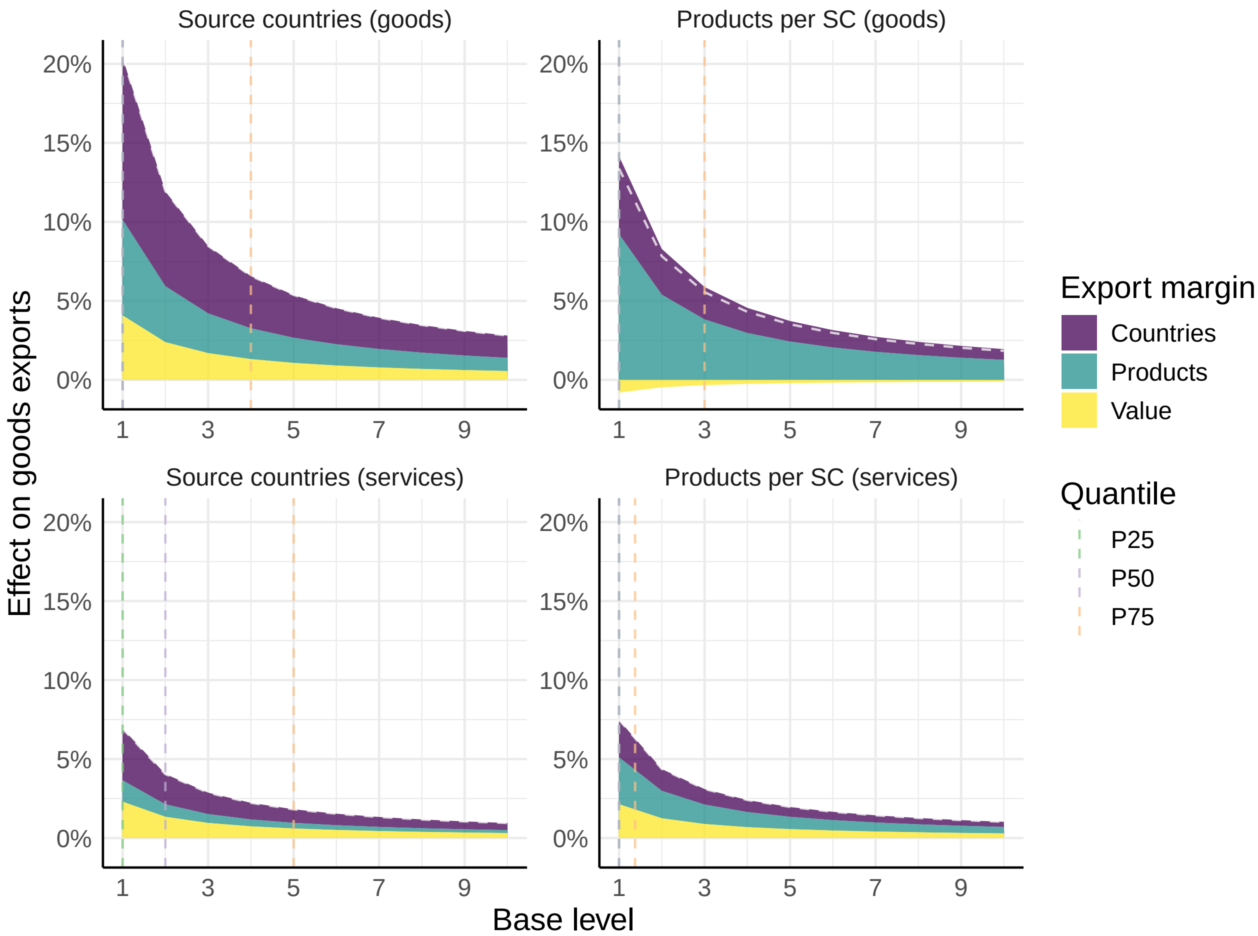
A Additional Results

A.1 Additional Figures

Figure A.1: Economic significance of estimated effects (lagged)



Source: Research Data Centre (RDC) of the Federal Statistical Office, project-specific data based on AFiD-Panel Außenhandelsstatistik (AHS), AFiD-Panel Unternehmensregister (URS) and AFiD-Modul Combined International Trade and Investment Data (CITID), 2011-2020, own calculations. Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, Statistics on International Trade in Services (SITS), 2011-2020, own calculations.
Note: Total effect on goods exports is indicated by the dashed white line. Excludes firms engaged in intra-EU trade below the reporting thresholds; see Fauth et al. (2023). Effects are based on the coefficient estimates in Table A.1 (lagged annual data). SC refers to source country.

A.2 Additional Tables

Table A.1: Margin complementarity regressions (lagged)

	Goods import margins only				
	(1)	(2)	(3)	(4)	(5)
	$\ln X_g$	$\ln n_g^d$	$\ln \bar{n}_g^{dp}$	$\ln \bar{x}_g$	$\ln S$
$\ln n_g^s$	0.261***	0.142***	0.0585***	0.0600***	0.142***
$\ln \bar{n}_g^{sp}$	0.144***	0.0565***	0.0794***	0.00812**	0.107***
$\ln \bar{m}_g$	0.0664***	0.0227***	0.000578	0.0431***	0.0410***
N			782,543		1,513,185

	Goods and service import margins				
	(1)	(2)	(3)	(4)	(5)
	$\ln X_g$	$\ln n_g^d$	$\ln \bar{n}_g^{dp}$	$\ln \bar{x}_g$	$\ln S$
$\ln n_g^s$	0.295***	0.148***	0.0874***	0.0589***	0.149***
$\ln \bar{n}_g^{sp}$	0.193***	0.0713***	0.133***	-0.0116	0.0937***
$\ln \bar{m}_g$	0.0892***	0.0228***	0.00346	0.0629***	0.0351***
$\ln n_s^s$	0.0999***	0.0472***	0.0195***	0.0332***	0.103***
$\ln \bar{n}_s^{sp}$	0.108***	0.0340***	0.0428***	0.0309*	0.0886***
$\ln \bar{m}_s$	0.0636***	0.0145***	0.0118***	0.0372***	0.0507***
N			87,097		112,987

Source: Research Data Centre (RDC) of the Federal Statistical Office, project-specific data based on AFiD-Panel Außenhandelsstatistik (AHS), AFiD-Panel Unternehmensregister (URS) and AFiD-Modul Combined International Trade and Investment Data (CITID), 2011-2020, own calculations. Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, Statistics on International Trade in Services (SITS), 2011-2020, own calculations.
Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Excludes firms engaged in intra-EU trade below the reporting thresholds; see Fauth et al. (2023). All regressions control for firm- and year-specific fixed effects. Estimation on yearly data, but using one-year lagged regressors. Firm and time indices i and t are suppressed for simplicity.

B Data Appendix

Data access was granted by the Research Data Centre of the Federal Statistical Office (DESTATIS) and the Research Data and Service Centre of the Deutsche Bundesbank as part of project 2023-0009. The data was accessed via "Gastwissenschaftlerarbeitsplatz" (GWAP, German for guest researcher workplace) and "Kontrollierte Datenfernverarbeitung" (KDFV, German for remote data processing).

B.1 Trade in goods: AHS

Our first dataset, AHS, is provided by the German Federal Statistical Office (DESTATIS) and covers virtually the entire universe of German goods-trade transactions (aggregated monthly) for the time period 2011 to 2020. Extra-EU trade is captured almost completely, with extremely low reporting thresholds, while the data on intra-EU trade face two challenges: first, intra-EU trade may be reported jointly by the overarching taxable entity and not necessarily by the individual underlying legal units, with the latter coming much closer to our understanding of firms in international trade. Second, intra-EU trade is subject to much more lenient reporting thresholds, so while most of the total export and import volumes are still captured, smaller firms are underrepresented in the raw data. To overcome both problems, DESTATIS has developed sophisticated estimation methods using auxiliary data such as VAT receipts to redistribute and estimate the jointly reported or missing import and export volumes; see Kruse et al. (2021).

The final dataset leaves us with trade flows by firm (i.e. the smallest legal unit required by law to keep books), time period (month or year), trade direction (export or import), partner country and product (8-digit Combined Nomenclature). See Fauth et al. (2023) for a thorough presentation and descriptive analysis.

Table B.1: Summary statistics on goods trade margins

Margin	Mean	SD	P1	P25	P50	P75	P99
X	4,075,245	171,800,000	0	0	5,600	188,170	50,902,649
M	3,223,115	88,054,772	0	162	7,987	208,776	40,024,270
n^d	4.76	10.90	0	0	1	3	54
n^s	3.65	6.22	0	1	1	4	31
$\bar{n}^{dp}$	2.79	11.36	0	0	1	2	36.91
$\bar{n}^{sp}$	2.82	5.53	0	1	1	3	22
$\bar{x}$	77,099	1,939,126	0	0	2,506	21,556	1,012,085
$\bar{m}$	105,224	5,381,244	0	102	2,205	21,922	1,414,167

Source: Research Data Centre (RDC) of the Federal Statistical Office, project-specific data based on AFiD-Panel Außenhandelsstatistik (AHS), 2011-2020, own calculations.
Note: Based on 2,495,017 observations over the years 2011-2020. Excludes firms engaged in intra-EU trade below the reporting thresholds; see Fauth et al. (2023). Firm and time indices i and t are suppressed for simplicity.

Table B.1 contains summary statistics for the goods trade margins described in chapter 3, computed using the AHS data and pooled over the entire period of observation from 2011 to 2020. Note that we restrict our sample to firms that exceed the intra-EU reporting thresholds, as we would otherwise lack the product-level information needed to compute all the margins.[12]

As is well-known in the empirical literature on firms in international trade, firm-level exports and imports are extremely skewed: While the median trading firm[13] exports and imports less than €10,000 per year, the firm at the 99th percentile exports and imports over €50 and €40 mio., respectively, leading to an arithmetic mean far above the median. A similar level of skewness can be found for the intensive margin, i.e. exports and imports per country and product. The two extensive margins, however, are much less skewed. At the extensive country margin, the median trading firm exports to and imports from a single country, while the average trading firm exports to almost 5 destinations and imports from 3.65 source countries. Similarly, we observe a single product exported and imported per country by the median firm, with the mean values not much higher at around 2.8 exported and imported products per country. See Fauth et al. (2023) for a more detailed discussion of these patterns.

B.2 Trade in services: SITS

The second dataset, SITS, mirrors AHS by providing information on German firm-level trade in services. SITS is our only dataset provided by the Deutsche Bundesbank, not DESTATIS. Service transactions are required to be reported as soon as they exceed a threshold value of €12,500. SITS provides us with the service exports and imports by firm, time period, partner country and service type (3-digit BMP6 codes used to construct the German balance of payments). See Biewen and Meinusch (2023) for further details.

When inspecting the summary statistics for the trade margins in SITS presented by Table B.2, we quickly realize the much scarcer presence of service trade compared to goods trade (roughly 300,000 pooled observations in SITS versus 2.5 mio. in AHS). Unfortunately, all information regarding the intensive margin of service imports had to be censored, but at least for service exports, we observe a similar level of skewness as for goods trade: Although the median service-trading firm only exports

[12] The thresholds are set to ensure trade volume coverage rates beyond 90%, so we still capture the vast majority of trade volume.

[13] Note that the underlying population we consider here contains all trading firms. The export margin, for instance, thus also takes into account firms that only import, hence why the first percentile is zero for all margins.

Table B.2: Summary statistics on service trade margins

Margin	Mean	SD	P1	P25	P50	P75	P99
X	10,157,237	244,884,840	0	≤ 500	51,000	996,000	115,261,000
M	-	-	-	-	-	-	-
n^d	3.54	8.30	0	0	1	3	38
n^s	4.86	8.99	0	1	2	5	42
n^{pd}	0.75	0.80	0	0	1	1	3.33
n^{ps}	1.12	0.82	0	1	1	1.375	4
$\bar{x}$	727,847	7,551,870	0	≤ 500	30,250	233,333	10,822,333
$\bar{m}$	-	-	-	-	-	-	-

Source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, Statistics on International Trade in Services (SITS), 2011-2020, own calculations.
Note: Based on 296,201 observations over the years 2011-2020. Missing values are due to censorship. Trade values in SITS are rounded to the nearest €1,000, which is why $P25$ of X and $\bar{x}$ are not exactly identified. Firm and time indices i and t are suppressed for simplicity.

€51,000 worth of services, the firm at the 99th percentile exceeds the €100 mio. mark, and the mean is €10 mio. The extensive country margin exhibits a pattern of much lighter skewness similar to that for trade in goods, with the median firm exporting services to one country and importing services from two countries, while the means stand at 3.54 and 4.86 countries, respectively. However, in contrast to goods trade, the extensive margin of the product appears to be much more symmetric, with the mean number of service types exported per country (0.75) actually below the median (1). This should not come surprising, though, as the 8-digit classification used for goods trade should naturally feature much more variation than the 3-digit service type classification.

B.3 Complete firm universe: URS

To capture the full relevance of international trade among all German firms, the third dataset we use for our analysis is the company register data set URS, again provided by DESTATIS. URS contains basic information on virtually all firms active in Germany, including sectoral affiliation, employment and sales revenues.

Table B.3: Trade participation among German firms

		Trade in...			
Year	**Domestic**	**Goods**	**Services**	**Both**	**Total**
2011	3,563,277	205,250	13,575	15,888	3,797,990
2012	3,583,617	204,346	13,915	16,263	3,818,141
2013	3,533,283	217,264	14,051	17,147	3,781,745
2014	3,547,574	226,447	12,289	15,588	3,801,898
2015	3,365,587	234,705	12,719	15,913	3,628,924
2016	3,368,430	242,127	13,235	16,226	3,640,018
2017	3,371,414	246,237	13,277	16,481	3,647,409
2018	3,372,401	249,506	13,278	16,955	3,652,140
2019	3,452,260	253,042	13,238	17,121	3,735,661
2020	3,263,049	252,230	12,761	16,281	3,544,321
Mean	3,442,089	233,115	13,234	16,386	3,704,825

Source: Research Data Centre (RDC) of the Federal Statistical Office, project-specific data based on AFiD-Panel Außenhandelsstatistik (AHS), AFiD-Panel Unternehmensregister (URS) and AFiD-Modul Combined International Trade and Investment Data (CITID), 2011-2020, own calculations. Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, Statistics on International Trade in Services (SITS), 2011-2020, own calculations.
Note: Excludes firms engaged in intra-EU trade below the reporting thresholds; see Fauth et al. (2023).

Table B.3 contains an overview over the evolution of the number of domestic and trading German firms from 2011 to 2020. Evaluating at the unweighted mean, about 3.44 out of the 3.7 mio. German firms (93%) were purely domestic, while 233 thousand (6.2 %) engaged in exports and/or imports of goods. A much smaller share of firms were either exclusively engaged in service trade or in both goods and service trade (roughly 0.4% each). Over time, these patterns can be observed very consistently, the only exception being a drop in mostly domestic firms from 2019 to 2020, most likely resulting from the Covid-19 pandemic.

B.4 Linking firm identifiers: CITID

Finally, we use CITID, provided jointly by DESTATIS and the Deutsche Bundesbank, to link the URS firm identifiers used in both AHS and URS to the “awmus” firm identifiers used by the Deutsche Bundesbank, allowing us to merge SITS to the remaining data. We refer the interested reader to Boddin et al. (2024) for details on this linkage procedure.

Appendix References

[1] Biewen, E., & Meinusch, A. (2023). Statistics on international trade in services (SITS) 01/2001 - 07/2023 (SITS), Data Report 2023-24 – Metadata ID SITS Version 7. Deutsche Bundesbank, Research Data and Service Centre.