# Three Essays on International Trade in Services

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# Introduction[*]

Global trade in services has risen tremendously in recent years. Yet, trade in manufacturing still accounts for the lion's share of trade worldwide. However, this picture masks the role of services value added embodied in manufacturing goods. Disentangling the overall traded manufacturing value-added on the one hand and services value added on the other hand embodied in destinations' final demand, Johnson (2014) finds that both account for roughly 40 percent of worldwide value-added exports. In addition, Johnson and Noguera (2016) show that the ratio of worldwide value-added exports to gross exports has been declining from 1970 to 2010 for manufacturing, while it has been increasing for services during the same period.

Another characteristic of global services trade is its high concentrated across countries. According to the World Trade Statistical Review 2017 published by the World Trade Organization, the top ten traders in commercial services accounted for 53 percent of the world's total trade in commercial services in 2016 with the USA, the UK, Germany and China among these top trading countries. A deepening of preferential trade agreements especially among these large players is likely to further boost global trade in services.

While there is a bulk of empirical work on the firm-level determinants for goods trade, research on services trade has only started very recently due to newly available micro-level data. This thesis tries to shed light on how firms' individual activities shape aggregate services trade on the one hand, and – given the recent threat of protectionism among major industrialised countries – how impediments to firms' international engagement in services trade may reduce overall welfare on the other hand. To this end, we use comprehensive information on German firms' services trade activities provided by the Deutsche Bundesbank.

The structure is as follows. Chapter 1 presents the cross-sectional distribution of German firms' engagement in international services trade and decomposes aggregate services exports and imports growth into firm-level contributions. Consistent with recent studies for other European countries, we find a fat-tailed distribution of firms' activities with respect to trading partners,

[*]The views expressed here and in the following chapters are those of the author and do not need to reflect those of the Deutsche Bundesbank.

services traded and the number of transactions. While firms trading larger volumes have been better able to cope with the economic slowdown in the aftermath of the financial crisis of 2007–2008, firms exporting smaller volumes grew more dynamically in other periods. This finding suggests that a reduction in services trade barriers could lay off unexploited growth potentials as it would enable these dynamically growing firms to serve customers internationally.

Chapter 2 analyses the role of microeconomic shocks to aggregate services trade volatility. We decompose services trade growth into shocks stemming from the macro-level and a firm-level component, that captures shocks to firms' individual trade relationships. We find idiosyncratic volatility to contribute most to overall services trade volatility. When consolidating shocks to individual trade relationships within firms, we find overall services trade volatility to decrease by roughly 40 percent.

Chapter 3 presents a multi-country-multi-sector model of international trade. In the empirical analysis using transaction- and firm-level data, we estimate the underlying deep parameters of the model and find considerable heterogeneity in the estimated elasticities across sectors and destination markets. Using these estimates, we find that overall services trade costs are significantly reduced by memberships in regional services trade agreements. In our counterfactual analyses we show that abandoning these services trade agreements for individual member countries reciprocally results in welfare losses that correspond to a notable share of a year's real income growth in many countries, with smaller countries being more affected. In addition, we find that the removal of existing services trade agreement memberships may have significant negative spill-over effects to real wages and profits in the manufacturing sector.

# Chapter 1

# Variations in Services Trade*

## 1.1 Introduction

International trade in services has become increasingly important in the last decades. Global services trade relative to world GDP grew from nearly eight percent in 1990 to more than 12 percent in 2012 with a total value of 24 percent relative to world's goods trade.[1] However, these figures obscure the actual impact of services for overall trade performance. For all EU countries in 2009, the share of value added of services embodied in gross exports in the manufacturing sector alone accounted on average for 33 percent, with a share of value added of imported services in gross exports of 16 percent.[2] In Germany, which is according to the World Trade Organization (2013) among the top three of the largest service exporters and importers worldwide, services exports only amount to 20 percent of total export revenues. However, when taking their value added content into account, services make up nearly 50 percent of overall exports, see Deutsche Bundesbank (2014).[3] Hence, when assessing a country's competitiveness in terms of export performance it is essential for academics and policy makers not only to focus on goods trade alone but also take a country's ability to trade efficient services into account.

In this paper, we analyse the micro-level foundations of services trade, *i.e.* we ask, how important firms' individual behaviour is in shaping variations in aggregate services trade. We disentangle the potential drivers of variations in services exports and imports along two dimensions: cross-sectional variation and variations over time. To this end, we use comprehensive firm-level information on services exports and imports at monthly frequency for the years 2001 to 2012 in Germany.

*This chapter is based on joint work with Elena Biewen (Deutsche Bundesbank). The above disclaimer applies.

[1] See http://unctadstat.unctad.org (accessed January 2014).

[2] See the OECD-WTO Trade in Value Added database (TiVA), http://stats.oecd.org (accessed January 2014).

[3] Jensen (2011) highlights the importance of services trade for the USA.

We proceed in two steps. First, we present cross-sectional patterns of firms' trade characteristics.[4] Consistent with previous studies, we find that there are significant differences in the decomposition of trade portfolios between firms with regard to the number of services traded, the number of trading partners and volume traded with the bulk of cross-border engagement concentrated on a small number of large firms.

Second, we provide evidence on how firm-level activities shape services trade over time. While there are many studies in goods trade using yearly data, empirical evidence using higher frequency data is rarer, see *e.g.* Bricongne et al. (2012) for an exception. Apart from changes in trade with established trade relationships, we find that the within-firm reallocation across trading partners and services significantly contributes to overall services trade growth, see *e.g.* Bernard et al. (2009a) for evidence for goods trade. In addition, we find that the gross contribution of firms' portfolio reshuffling significantly increases at monthly frequency. Hence, yearly data consolidates a lot of firms' activities in the course of a year.

Since our data also covers the years 2008 to 2009, which are associated with a worldwide drop in goods trade, we also analyse how firms engaged in services trade adjusted their trade portfolios in response to a global shock. Consistent with evidence for Belgium, see Ariu (2016a), we find aggregate services exports and imports to have declined only very moderately with the intensive margin, *i.e.* changes in trade flows with established trade relationships, being the main contributor. In contrast, the extensive margin, *i.e.* firms' entry into or exit from export activities as well as new trade relationships, *i.e.* new trading partners and newly traded services among firms already engaged in services trade, alleviated the decline in services exports.

Though adjustment patterns of the average exporter and importer with respect to services and trading partners are very similar over time, we find significant differences, when it comes to the performance of firms in different size classes. Given their relatively better diversification, large services exporting firms were better able to cope with the collapse in goods trade from 2008 to 2009. However, small exporting firms grew most dynamically in all other years. While we find similar patterns for the years 2008 to 2009, small importing firms grew least dynamically in all other periods reflecting their low activity in the course of a year compared to small exporting firms.

The paper is structured as follows. Section 1.2 gives a description of our data. Section 1.3 presents key characteristics of the cross-sectional variation between firms. Section 1.4 shows

[4] Cross-sectional features of firms engaged in services trade have also been documented *e.g.* by Breinlich and Criscuolo (2011) for the UK, Federico and Tosti (2012) for Italy and Ariu (2016b) for Belgium. Kelle and Kleinert (2010), who use information for 2005, were the first to provide empirical characteristics of firms' services export and import behaviour in Germany. Since our data are more disaggregated, we extend their analysis by explicitly accounting for firms' activity in the course of a year.

how firm-level activity shape aggregate variations over time. Section 1.5 concludes.

## 1.2 Data

We use a unique micro dataset on Statistics on International Trade in Services (SITS) compiled by the Deutsche Bundesbank. The database covers services transactions between German residents (non-financial firms, banks, individuals, public authorities) and non-residents and contains comprehensive information on each reported services transaction for the years 2001 to 2012.[5] Each service transaction needs to be reported if the value of incoming or outgoing payments exceeds 12,500 Euro.[6] This reporting requirement has not changed during 2001 to 2012. Given that reports may also be submitted electronically, many firms also report payments below this threshold. The reporting threshold has to be applied to the total amount per month, country and type of service. Hence, one transaction in a given month that we see in the data may actually comprise several incoming or outgoing payments during that month.

Our data covers three modes of the General Agreement on Trade in Services: Mode 1, cross-border supply (supplier and customer exchange services without leaving their domestic country), Mode 2, consumption abroad (customers move to the country of the supplier), and Mode 4, presence of a natural person (suppliers move to the country of the customer). We cannot distinguish between the different types of modes, and not any information on trade via Mode 3, commercial presence abroad, which captures services sales of affiliated firms located in the country of the customer. However, since we are interested in how firms shape aggregate services exports and imports as part of the official Balance of Payments Statistics and to be able to compare our results to findings in the goods trade literature, this is not restrictive.

The data comprise information on the value of each exported or imported transaction, the individual type of service traded, the destination or source country, and the industry of the firm.[7] Though we do not have any further information on firm characteristics, the data give a comprehensive picture of the nature of services trade, its composition and differences in trading patterns and services at the firm-level. Since our focus is on firms' activities, we exclude private transfers, and transactions undertaken by international organizations, federal and communal

[5]The legal basis for collecting the data in order to compile the Balance of Payments Statistics are the Foreign Payments Act (Section 11(2)), and the Foreign Trade and Payments Regulation (Section 67). The Act on Statistics for Federal Purposes also applies.

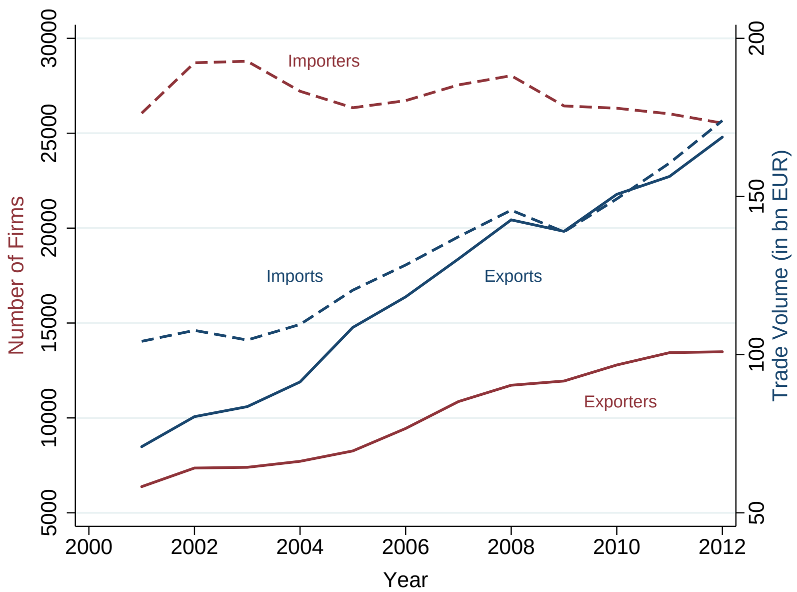
[6]Payments have to be reported according to the gross settlement principle, *i.e.* incoming and outgoing flows must be reported separately, not netted.

[7]The industry classification is based on Nace Rev. 1.1 (two digits) and reflects firms' main economic activity. Firms are legally distinct entities. Even if a legally independent German firm belongs to a holding, it is obliged to report its service transactions.

institutions as well as households. In addition, we drop reinsurance services since these flows are often netted in official statistics and hence, would bias our aggregate series. Our sample covers more than 75 percent of Germany's aggregate services trade as reported in the Balance of Payments Statistics in an average year, more than 200 countries and 73 individual services which are listed in Table A.1.1.

To get a first impression of the data we use, Figure 1.1 shows the number of German services exporters and importers as well as the volume of exports and imports in billions of Euro for the years 2001 to 2012.[8] As can be seen in Figure 1.1 the number of importers is remarkably stable over time with an average of 27,000 firms per year. In contrast, the number of exporters steadily increases from roughly 6,000 firms in 2001 to more than 13,000 firms in 2012. The volume of imports and exports grows over the entire time span, with the exception of 2008 to 2009, which coincides with the collapse in goods trade. The volume of imports increases by 67 percent whereas exports increase by nearly 140 percent between 2001 and 2012. Despite the smaller number of exporting firms, the difference in traded volumes is decreasing for the years 2001 to 2008 and is almost vanishing for the subsequent years. Hence, on average, exporters trade higher volumes than importing firms.

Figure 1.1: Number of Firms and Trade Volume, 2001-2012




In goods trade, the industry a firm belongs to (*e.g.* a manufacturer of motor vehicles) and

[8]Since services trade exhibits a lot of seasonality at lower frequencies, we focus on yearly figures here.

the type of good it is shipping (*e.g.* cars) usually are used interchangeably in the literature. In services trade, however, this distinction is essential. Figure 1.2 shows the average trade of selected service categories by individual German industries for the years 2001 to 2012. The figures for exports and imports are in the top and bottom panel, respectively.[9]

Figure 1.2 shows that not only pure service industries are engaged in services trade, which is consistent with the findings of Kelle and Kleinert (2010) and Breinlich and Criscuolo (2011). In fact, every sector is active in trading all depicted service categories (though to a different extent) with the manufacturing sector being one of the most important players, both, in terms of the number of services traded and traded volume.[10] While industries like transport or finance clearly dominate exports and imports of the service category they are associated with, the manufacturing sector even trades more construction and business services than the construction and business sectors do, respectively. These figures are very similar for services exports and imports across industries. Hence, apart from services that support the ongoing business of a firm (such as back office activities), services do not only enter the value chain as an input in firms' production processes (such as R&D or design), they also represent part of firms' "output" even if they do not belong to the services industry.[11]

## 1.3 Cross-Sectional Variation

In this section we look at the cross-sectional variation of services trade between firms. Table 1.1 shows the extensive and intensive variation of services exports and imports between firms for the years 2001 to 2012. The extensive variation is given by the number of services, countries, trade relationships, transactions as well as transactions per trade relationship. Throughout the paper, we refer to a trade relationship as an observed firm-country-service triplet in a period of time, which is a year in this case. The intensive variation is captured by firm-level exports per transaction and per trade relationship, as well as the total amount traded.

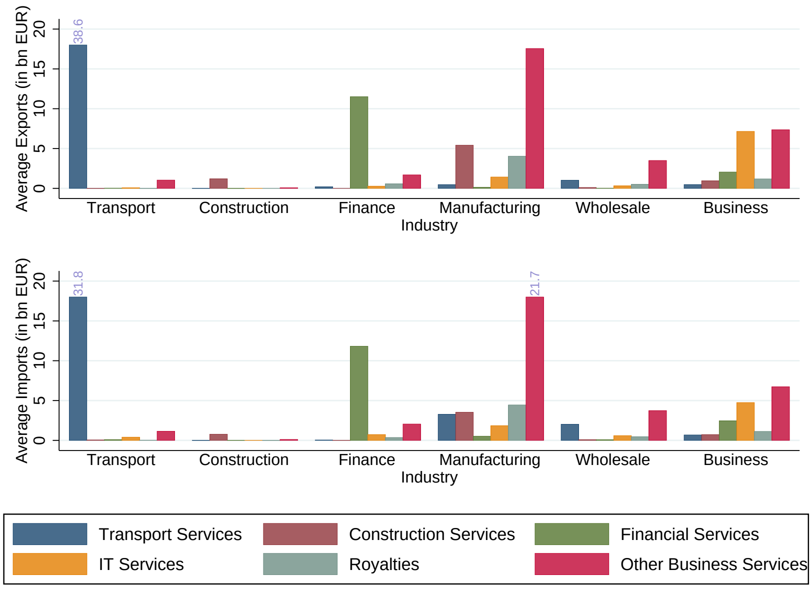
The first column shows average characteristics of firms' trade portfolios for the pooled sample. The average exporter trades 1.6 services with 5.5 countries. These numbers are very close to those found by Breinlich and Criscuolo (2011) for the UK, also one of the largest services traders worldwide, but somewhat larger than those reported by Ariu (2016b) for Belgium. However, since the average number of trade relationships is only 7.1, exports of firms' individual services

[9]The service categories are based on the Extended Balance of Payments Services Classification (EBOPS), see Table A.1.1.

[10]Kelle (2012) provides a detailed analysis of German manufacturers engaged in services trade.

[11]Carry-along trade observed in goods trade, as analysed by Bernard et al. (2012a), is less an issue for services trade since services are non-storable and have to be consumed immediately after their supply, with trade in rights being an important exception.

Figure 1.2: Average Services Trade by Industry, 2001-2012




*Notes:* This figure shows the average traded volume in bn. Euro of service categories by industries for the yearly sample from 2001 to 2012. Each bar represents the a service category which are based on the Extended Balance of Payments Services Classification (EBOPS) and listed in Table A.1.1. "Manufacturing" and "Construction" and "IT" denote the respective industries, "Finance" denotes financial intermediaries and insurance companies, "Wholesale" also includes retail trade, "Transport" also includes storage and the communication industry, and "Business" includes business activities, real estate, and renting. For expositional reasons, numbers over truncated bars denote the actual volume traded.

are not evenly spread across countries. For exporting firms, the average number of transactions is 27.4, but they only serve each trade relationship three to four times a year as given by the number of transactions per trade relationship.[12] The finding of infrequent trade is also consistent with recent evidence for goods trade, see *e.g* Alessandria et al. (2010) and Kropf and Sauré (2014), and Belgian services traders, see Ariu (2016b). Along the lines of Hornok and Koren (2015), Ariu (2016b) argues that costs per transaction lead firms to trade only infrequently to reduce costs. There may be two further reasons for this observation. First, services trade often involves longer-term contracts where the provision of services in the course of a year may be consolidated in a single payment, *e.g.* insurance services. Second, some business services may not be due

[12] As noted in the previous section, a transaction is a firm-service-country-level trade flow in a given month. In principle, this volume may comprise several trade flows within that month (which we do not observe). The number of actual transactions within that month may thus be larger. The maximum number of transactions per trade relationship that we can observe in a given year is thus bounded above by 12.

Table 1.1: Heterogeneity Between Firms, Averages for 2001-2012

| | | Percentile intervals based on firm size | | | | | |
|---|---|---|---|---|---|---|---|
| | Full sample | <1 | 1–25 | 25–50 | 50–75 | 75–99 | $\geq$ 99 |
| *Exports* | | | | | | | |
| Number of firm-level | | | | | | | |
| services | 1.6 | 1.1 | 1.1 | 1.3 | 1.6 | 2.4 | 5.5 |
| countries | 5.5 | 1.2 | 1.4 | 2.6 | 4.7 | 11.9 | 41.4 |
| trade relationships | 7.1 | 1.2 | 1.5 | 2.8 | 5.4 | 15.6 | 82.3 |
| transactions within a year | 27.4 | 1.3 | 2.6 | 7.4 | 16.8 | 65.7 | 464.4 |
| transactions per relationship | 3.5 | 1.1 | 1.7 | 3.2 | 4.2 | 4.9 | 5.8 |
| Average firm-level exports per | | | | | | | |
| transaction | 277 | 5 | 30 | 75 | 180 | 689 | 3,817 |
| trade relationship | 1,193 | 5 | 45 | 200 | 638 | 2,985 | 23,884 |
| Total exports per firm | 11,928 | 5 | 62 | 368 | 1,506 | 20,053 | 616,188 |
| Firm-year observations | 120,791 | 830 | 29,201 | 30,295 | 30,209 | 28,955 | 1,301 |
| *Imports* | | | | | | | |
| Number of firm-level | | | | | | | |
| services | 2.3 | 1.0 | 1.1 | 1.5 | 2.2 | 4.2 | 10.4 |
| countries | 4.5 | 1.1 | 1.2 | 2.1 | 3.9 | 9.7 | 35.8 |
| trade relationships | 6.7 | 1.1 | 1.3 | 2.3 | 4.8 | 15.3 | 93.5 |
| transactions within a year | 21.1 | 1.2 | 1.6 | 4.3 | 12.2 | 50.3 | 433.9 |
| transactions per relationship | 2.3 | 1.1 | 1.2 | 1.9 | 2.7 | 3.5 | 4.8 |
| Average firm-level imports per | | | | | | | |
| transaction | 122 | 2 | 20 | 44 | 76 | 257 | 2,468 |
| trade relationship | 381 | 2 | 23 | 66 | 162 | 876 | 10,486 |
| Total imports per firm | 4,882 | 2 | 26 | 113 | 465 | 6,858 | 300,184 |
| Firm-year observations | 323,714 | 2,552 | 77,695 | 81,360 | 81,097 | 77,683 | 3,327 |

*Notes*: Trade volumes are rounded and reported in thousand Euro. Transactions denote the number of firm-service-country trade flows within a given year. A trade relationships is a unique firm-service-country triplet. Each line shows the average values for the full sample and segments of the firm size distribution, respectively. Size classes are constructed by ranking firms within each industry by their yearly exports or imports and grouping into percentile intervals.

every month but have a lower recurrence frequency, *e.g.* outsourced bookkeeping, such as a financial statement, or maintenance of machines. In that sense, some services have a "durable" character.[13] These numbers for the extensive margins are also mirrored by the volumes exported

[13] Kropf and Sauré (2014) argue that goods exporting firms face a trade-off between costs per shipment and inventory holding costs. Using information on Swiss firms' goods exports at the transaction-level, the authors find that costs per shipment are economically important. However, this trade-off merely applies to firms engaged in services trade since storage is not an issue by the nature of services.

with average exports per trade relationship being more than four times larger than exports per transaction.

In addition to averages across firms, columns two to seven of Table 1.1 also show the distribution of firms' trade portfolios across size classes.[14] Consistent with Breinlich and Criscuolo (2011) and Ariu (2016b), Table 1.1 reveals large differences in firms' cross-border engagement. While on average, firms with an export volume below the first percentile only trade 1.1 services with 1.2 countries via 1.3 transactions within a year, the top percentile of firms export 5.5 services to 41.4 countries via 464.4 transactions. This heterogeneity is even more pronounced in terms of average export volumes. Firms in the top percentile export roughly 123,000 times more than firms with export volumes below the first percentile. The finding of a fat-tailed distribution of firms' export behaviour along the extensive and the intensive margin is also consistent with evidence for goods trading firms, see *e.g.* Bernard et al. (2009c, 2010), and Arkolakis and Muendler (2013), and firms' activities more generally, see *e.g.* Gabaix (2009).

The value of exports for firms with the lowest trading volumes is only 5,000 Euro, which is below the reporting threshold of 12,500 Euro. Even firms with an export volume between the first and below the 25th percentile only exhibit export values of 30,000 Euro per transaction. These relatively small export volumes of a relatively large number of firms are hard to reconcile with a theoretical model where all firms face the same market access cost that only larger firms are able to cover as in Melitz (2003). This finding rather suggests that firms endogenously choose their individual degree of market penetration, as in Arkolakis (2010) and Eaton et al. (2011).

The bottom panel of Table 1.1 shows the characteristics for service sourcing firms. While the patterns of extensive and intensive variation of cross-border engagement are qualitatively similar to exporters, we find differences in the magnitude. Consistent with Figure 1.1, total services imports per firm across all size classes are not even half as large as exports. However, while the number of trade relationships is by and large the same, importers source more services from fewer countries and are less active in importing in the course of a year, which suggests that service importers are relatively more impeded by market-specific rather than service-specific trade costs.

In order to disentangle the drivers of the variation between firms, we follow Bernard et al. (2009a) and decompose export or imports of firm $f$, $x_f$, into the number of country-service relationships of firm $f$, $o_f$, and the intensive margin of the traded value of firm $f$ per trade relationship, $x_f/o_f$. The number of country-service relationships, $o_f$, can be further split up into three extensive components: the number of countries firm $f$ is trading with, $c_f$, the number

[14] We rank firms within each industry by their yearly exports or imports and group them into size classes. We use size classes instead of percentiles of the distribution of services, countries, etc. in order to compare the same set of firms for each item.

of traded services, $s_f$, and trade density, the number of trade relationships of firm $f$ over all possible country-service combinations, $d_f = o_f/(c_f s_f)$.

We can further extract an additional extensive component from the intensive margin, $x_f/o_f$, by introducing a term which we label activity, given by $a_f = tr_f/o_f$. Activity measures how often, as given by the number of transactions, $tr_f$, firm $f$ trades with an observed country-service relationship within a period of time.[15] While applied to the cross-section, this measure has an inherent intertemporal nature as it captures part of firms' diversification over time. Given activity, the intensive margin can intuitively be expressed as the volume traded per transaction, $\bar{x}_f = x_f/tr_f$.[16] Total trade of firm $f$ for a given year $t$ can then be expressed by the following identity:

$$x_{ft} = c_{ft} s_{ft} d_{ft} a_{ft} \bar{x}_{ft}. \tag{1.1}$$

In order to asses the contribution of the intensive and four extensive margins for the variation of exports and imports between firms, we regress the logarithm of each margin on the logarithm of total trade of firm $f$ year $t$ in a pooled OLS using yearly data. As equation (1.1) holds by definition, the estimated elasticities capture the average percentage contribution to the between-firm variation of each margin. Table 1.2 reports the relative contribution of each margin for the full sample, for firms trading volumes below the 25th percentile and the top one percent of traders.

For the full sample, the intensive margin accounts for nearly 49 and 41 percent of the total variation across firms for exports and imports, respectively.[17] Trading partners and services account for 30 and 10 percent, respectively, for the variation of exporters, but are somewhat more important for the variation across importers, with 34 and 21 percent, respectively. Since firms trading smaller amounts only have one trading partner and trade one service, the contribution of the country and service margin is smaller compared to the largest firms and the intensive margin is most important. For firms exporting smaller volumes this is also accompanied by a higher dispersion of activity, the number of transactions per trade relationship in the course of a year, which contributes to the cross-sectional variation with 21 percent compared to 18 percent for

[15] Ariu (2016b) also points to the importance of transactions for explaining the cross-sectional variation in services trade. He includes the number of transactions as an additional extensive margin directly.

[16] This decomposition nests the one proposed by Bernard et al. (2009a). In addition, it also avoids a potential "partial year effect", a term coined by Bernard et al. (2014) in the context of firm entry dynamics. However, this effect may also apply to cross-sectional analyses: For two otherwise identical firms that start exporting in different months, the number of observed transactions may vary and, hence, lead to differences in intensive margins.

[17] Taking differences in the decompositions into account, these numbers are somewhat larger than those reported by Ariu (2016b), who finds the intensive margin to contribute only to 35 percent to the cross-sectional variation of Belgium exporting and importing firms.

Table 1.2: Between-Firm Margins, 2001-2012

| | *Exports* | | | *Imports* | | |
|---|---|---|---|---|---|---|
| Margin | Full Sample | <25 | ≥ 99 | Full Sample | <25 | ≥ 99 |
| Countries | 0.297 | 0.140 | 0.318 | 0.339 | 0.082 | 0.425 |
| | (0.003) | (0.004) | (0.082) | (0.002) | (0.002) | (0.040) |
| Services | 0.097 | 0.034 | 0.273 | 0.210 | 0.050 | 0.222 |
| | (0.002) | (0.002) | (0.102) | (0.001) | (0.001) | (0.039) |
| Density | −0.062 | −0.017 | −0.147 | −0.141 | −0.031 | −0.082 |
| | (0.001) | (0.001) | (0.057) | (0.001) | (0.001) | (0.024) |
| Activity | 0.179 | 0.209 | 0.103 | 0.187 | 0.069 | 0.064 |
| | (0.001) | (0.005) | (0.038) | (0.001) | (0.002) | (0.015) |
| Intensive | 0.489 | 0.636 | 0.453 | 0.405 | 0.830 | 0.371 |
| | (0.003) | (0.006) | (0.103) | (0.002) | (0.003) | (0.047) |
| Obs. | 120,791 | 30,031 | 1,301 | 323,714 | 80,247 | 3,327 |

*Notes*: Pooled estimates of the contribution of margins to cross-sectional variation in firm-level exports and imports for the years 2001 to 2012 for the full sample, for firms trading volumes below the 25th percentile ("<25") and for the top percent of traders ("≥ 99"). Industry-year effects are included. Clustered standard errors are in parentheses.

the full sample. However, we find the opposite to be true for firms importing smaller volumes, where the contribution is only 7 percent compared to 19 percent for the full sample. Hence, even if the difference between the smallest exporters and importers in the number of transactions per trade relationships is not very pronounced, see Table 1.1, this small contribution reveals that the average value of 1.2 transactions per trade relationship for firms importing volumes between the 1st and the 25th percentile varies only very little, implying that small importing firms are far less active than small exporters.

## 1.4 Time-Series Variation

In this section we analyse to what extent changes in the observed cross-sectional patterns contribute to the variation of aggregate services trade along the time dimension. To this end, we proceed in two steps. First, we show how firm entry and exit as well as the reallocation of resources within incumbent firms contribute to overall services trade growth. Second, we disentangle individual growth rates to assess the relative performance of services, trading partners, and firms over time. Since our data also cover the years 2008 to 2009, which are associated with the collapse in goods trade, we can also assess how firms engaged in services trade adjusted their trade portfolios in response to a global shock.

### 1.4.1 Reallocation Over Time

In order to quantify changes over time, we follow the methodology by Davis and Haltiwanger (1992) and use mid-point growth rates which have become a standard measure of change in labour economics, and have also been recently applied to goods trade, see *e.g.* Bricongne et al. (2012). Compared to conventional growth rates or log-changes, mid-point growth rates have the advantage to allow for an explicit assessment of the contributions of entering and exiting firms as well as changes in the distribution of trading partners and services within established firms' portfolios to overall growth. An individual mid-point growth rate of a trade flow of firm $f$ between $t$ and $t-1$ is given by the ratio of the total change in trade of service $s$ with country $c$ to the average traded value of firm $f$ with country $c$ of service $s$ between $t$ and $t-1$:

$$\gamma_{fcst} = \frac{x_{fcst} - x_{fcst-1}}{0.5\left(x_{fcst} + x_{fcst-1}\right)} .$$

The mid-point growth rate of total trade between two periods is the weighted sum of individual growth rates:

$$\gamma_t = \sum_{fcs} w_{fcst}\gamma_{fcst} ,$$

where the weights $w_{fcst}$ are given by

$$w_{fcst} = \frac{x_{fcst} + x_{fcst-1}}{\sum_{fcs} x_{fcst} + \sum_{fcs} x_{fcst-1}} . \tag{1.2}$$

Each individual growth rate at the firm-country-service level can be attributed to one of the following groups: entering and exiting firms, and incumbents. Changes in trade portfolios of incumbents can be further decomposed into born and retired relationships with trading partners, added and dropped services and growing and shrinking growth rates of ongoing country-service relationships. We thus end up with six extensive and two intensive (gross) margins. This hierarchy implies a pecking order. Trade with a new country may occur through a new or an already existing service, *i.e.* the set of added services only captures service creation among existing trading partners. The same downward bias of service switching in favor of the country margin holds for service destruction.

We decompose total services exports and imports for monthly, quarterly and yearly frequencies for the years 2001 to 2012. The results of this decomposition are given in Tables 1.3 and 1.4. To deal with seasonality, quarterly and monthly growth rates are based on year-on-year changes. The first three columns report the averages of growth rates for the period 2001 to 2008 for the respective frequencies. The subsequent columns show growth rates for individual years

Table 1.3: Contributions to Mid-Point Growth in Service Exports, Full Sample

| | 2001-2008 | | | 2008-2009 | | | 2009-2010 | | | 2010-2011 | | | 2011-2012 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | mth | qrt | yr | mth | qrt | yr | mth | qrt | yr | mth | qrt | yr | mth | qrt | yr |
| *Firm Entry and Exit* | | | | | | | | | | | | | | | |
| Entry | 10.8 | 7.6 | 4.8 | 7.1 | 4.9 | 2.9 | 5.7 | 4.0 | 2.5 | 4.9 | 3.2 | 1.4 | 4.3 | 2.6 | 1.5 |
| Exit | −6.7 | −4.2 | −2.3 | −4.8 | −3.2 | −1.8 | −4.3 | −2.6 | −1.3 | −3.7 | −2.2 | −1.1 | −3.6 | −2.1 | −1.0 |
| Net Entry | 4.1 | 3.3 | 2.5 | 2.3 | 1.8 | 1.0 | 1.4 | 1.4 | 1.2 | 1.2 | 1.0 | 0.3 | 0.7 | 0.6 | 0.5 |
| *Trade Relationships* | | | | | | | | | | | | | | | |
| Born | 11.2 | 7.1 | 3.5 | 10.6 | 6.3 | 2.7 | 10.2 | 6.2 | 3.1 | 10.3 | 6.1 | 3.0 | 11.0 | 6.7 | 3.4 |
| Retired | −9.1 | −5.5 | −2.3 | −9.7 | −5.2 | −2.1 | −9.7 | −5.6 | −2.1 | −8.4 | −4.6 | −1.9 | −8.7 | −4.8 | −1.9 |
| Net Country | 2.1 | 1.7 | 1.1 | 0.9 | 1.1 | 0.6 | 0.5 | 0.7 | 1.1 | 1.8 | 1.5 | 1.1 | 2.4 | 1.9 | 1.5 |
| *Service-Switching* | | | | | | | | | | | | | | | |
| Added | 6.3 | 5.0 | 3.5 | 6.4 | 5.5 | 4.4 | 5.5 | 4.2 | 2.3 | 5.3 | 3.5 | 2.3 | 6.1 | 4.7 | 3.5 |
| Dropped | −5.0 | −3.9 | −2.7 | −5.1 | −3.9 | −2.3 | −5.4 | −3.7 | −2.6 | −5.0 | −3.7 | −1.8 | −4.7 | −3.2 | −1.7 |
| Net Service | 1.3 | 1.1 | 0.8 | 1.2 | 1.6 | 2.0 | 0.1 | 0.5 | −0.3 | 0.3 | −0.2 | 0.5 | 1.3 | 1.5 | 1.8 |
| *Intensive Margin* | | | | | | | | | | | | | | | |
| Increases | 25.1 | 25.2 | 24.3 | 20.8 | 20.4 | 19.1 | 27.9 | 27.1 | 25.0 | 23.0 | 22.4 | 20.1 | 23.5 | 22.9 | 20.2 |
| Decreases | −22.0 | −20.6 | −18.1 | −28.0 | −27.3 | −25.2 | −21.3 | −21.2 | −18.5 | −22.7 | −21.2 | −18.4 | −20.5 | −19.5 | −17.0 |
| Net Intensive | 3.1 | 4.5 | 6.2 | −7.2 | −7.0 | −6.1 | 6.6 | 5.9 | 6.5 | 0.3 | 1.2 | 1.7 | 3.0 | 3.3 | 3.2 |
| Total Change | 10.6 | 10.6 | 10.6 | −2.8 | −2.5 | −2.5 | 8.6 | 8.4 | 8.4 | 3.6 | 3.6 | 3.6 | 7.5 | 7.3 | 7.1 |

*Notes*: Percentage contribution of each margin to changes in total Exports calculated as simple averages of mid-point growth rates over the respective time interval (with the exception of yearly figures for 2009 to 2012).

where monthly and quarterly growth rates are averaged over the respective period. Aggregate growth rates are reported in the last row.

For the years 2001 to 2008 the average mid-point growth rate of services exports is 10.6 percent with positive net contributions of all margins. At yearly frequency, the most important contributor is the intensive margin with 6.2 percent. Among the extensive margins, the impact of net firm entry is highest, followed by trading partners and service switching which may partially reflect the ordering of margins when calculating mid-point growth rates as noted above. At quarterly and monthly frequency, we find the net extensive margin to explain more than 58 to almost 71 percent of overall growth, respectively, with roughly 45 percent of that contribution being due to within-firm switching among trading partners and services.[18]

In addition to the impact of net contributions, there are a lot of dynamics when looking at gross contributions of margins. While the impact is largest for increased and decreased trade flows among established country-services trade relationships, gross contributions of firm entry and exit as well as country- and service-switching are far from being negligible. Apart from reallocation across firms in response to changes in the macroeconomic environment, this points to the importance of reallocation of incumbent firms' individual trade portfolios with regard to trading partners and services, which is consistent with findings for goods trade, *e.g.* Bernard et al. (2012b), and recent models of goods trade emphasizing the endogenous selection of products and trading partners within firms, *e.g.* Eckel and Neary (2010), Bernard et al. (2011), and Arkolakis and Muendler (2015).[19] We find significant differences in the gross contribution of firms' activities across frequencies. While the contribution of born and retired trading partners at yearly frequency is 3.5 and -2.3 percent, respectively, their gross contribution amounts to 11.2 and -9.1 percent at monthly frequency, respectively, which is consistent with findings of Bricongne et al. (2012) for French goods exporters. Table 1.3 shows that the increase in gross contributions at higher frequencies also holds for entries and exits of firms and service switching and for all years. Hence, the consolidation of individual transactions at lower frequencies cushions the relatively higher gross contributions to growth within a period and thus conceals firms' actual activity in the course of a year.

During the global recession of the years 2008 to 2009 world trade collapsed by almost 30

[18]These findings are larger than those reported by Bricongne et al. (2012) for goods exports in France. For the years 2000 to 2007 the authors find the net extensive margin to contribute to 52 and 57 percent at yearly and monthly frequency, respectively.

[19]Bernard et al. (2009b) find product-country switching to account for 25 percent of average export growth for the years 1993 to 2003 (excluding the years around the recession in the USA 2000 to 2002). At yearly frequency we find service-country switching to contribute to 19 percent to overall service export growth. However, given that we only observe 73 individual services compared to the ten-digit Harmonized System classification observed by Bernard et al. (2009b), this number is likely to be downward biased.

percent while trade in services remained remarkably stable during that period, see Eaton et al. (2015) and Borchert and Mattoo (2010). Table 1.3 shows that also German services exports only moderately declined by not even 3 percent. Possible reasons are that demand for services is less cyclical and their provision is less finance-dependent compared to goods trade, see Borchert and Mattoo (2010) and Ariu (2016a) for a discussion. As can be seen in Table 1.3, this decline can exclusively be ascribed to the intensive margin. That the intensive margin is the main driver during the trade collapse is consistent with findings by Bricongne et al. (2012) and Behrens et al. (2013) for goods trade and Ariu (2016a) for Belgium services trade. Table 1.3 shows that the contribution of shrinking exports exceeds (in absolute terms) the still considerable growth in increasing export sales (-28.0 and 20.8 percent at monthly frequency, respectively). In contrast, the net contributions of all extensive margins are positive and even alleviated the decline in services exports. Gross contributions of added and dropped services increase compared to the years 2001 to 2008 indicating an active reshuffling of firms' portfolio along the service dimension.

For the years following the goods trade collapse, aggregate export growth is positive with all margins contributing positively (with minor exceptions). The intensive margin is the main driver for the recovery in 2009 to 2010 with a growth rate of roughly 6 percent which may also reflect a catching-up effect after the downturn. For aggregate services exports, we cannot deduce any significant effect of the Eurozone debt crisis on services exports for the years 2009 onwards. If anything, there is a reduction in the contribution of service-switching for the periods 2009 to 2010 and 2010 to 2011 compared to previous years.

Table 1.4 presents the results for services imports. We find similar patterns to that of services exports for the years 2001 to 2008. However, firm exit, retired trading partners and dropped services are quantitatively more important than for exports with net firm entry contributing negatively or very little to growth in all subsequent years. Services imports fell by roughly 5 percent from 2008 to 2009 with the main driver again being the intensive margin. In addition to a positive net contribution, the gross margin of added services also increases, while the contribution of dropped services decreases (in absolute terms), pointing again to an active rebalancing of firms' trade portfolios in terms of services.

### 1.4.2 Reallocation Across Services, Trading Partners, and Firms

To gain further insights into the adjustment across firms, we next analyse the performance of firms in different size classes. We do so by controlling for developments in markets and services traded, which allows an assessment of how services and countries are affected by the average firm's portfolio adjustment.

For expositional reasons, we cluster services according to the EBOPS classification given

Table 1.4: Contributions to Mid-Point Growth in Service Imports, Full Sample

| | 2001-2008 | | | 2008-2009 | | | 2009-2010 | | | 2010-2011 | | | 2011-2012 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | mth | qrt | yr | mth | qrt | yr | mth | qrt | yr | mth | qrt | yr | mth | qrt | yr |
| *Firm Entry and Exit* | | | | | | | | | | | | | | | |
| Entry | 8.6 | 5.7 | 3.2 | 5.0 | 3.3 | 1.6 | 5.5 | 3.1 | 1.6 | 4.8 | 2.9 | 1.4 | 3.8 | 2.2 | 1.0 |
| Exit | −8.1 | −5.4 | −2.9 | −5.6 | −3.6 | −1.6 | −6.9 | −4.7 | −1.7 | −4.6 | −2.9 | −1.5 | −3.9 | −2.3 | −1.2 |
| Net Entry | 0.6 | 0.4 | 0.4 | −0.6 | −0.3 | −0.0 | −1.4 | −1.5 | −0.1 | 0.2 | −0.0 | −0.1 | −0.1 | −0.1 | −0.2 |
| *Trade Relationships* | | | | | | | | | | | | | | | |
| Born | 11.8 | 7.6 | 4.0 | 10.3 | 6.2 | 3.0 | 10.3 | 6.4 | 3.4 | 9.1 | 5.6 | 2.8 | 9.2 | 5.6 | 2.6 |
| Retired | −10.3 | −6.7 | −3.4 | −9.9 | −6.1 | −3.3 | −8.7 | −5.6 | −3.9 | −8.2 | −4.8 | −2.2 | −7.8 | −4.6 | −2.0 |
| Net Country | 1.5 | 0.9 | 0.5 | 0.4 | 0.2 | −0.3 | 1.6 | 0.8 | −0.5 | 1.0 | 0.7 | 0.5 | 1.4 | 1.0 | 0.6 |
| *Service-Switching* | | | | | | | | | | | | | | | |
| Added | 10.0 | 8.0 | 5.3 | 10.4 | 8.4 | 5.5 | 9.4 | 7.6 | 5.0 | 9.9 | 7.0 | 4.1 | 9.3 | 6.3 | 3.7 |
| Dropped | −9.4 | −7.2 | −4.8 | −8.4 | −6.5 | −3.9 | −8.8 | −6.5 | −4.1 | −8.1 | −6.0 | −3.1 | −7.4 | −5.1 | −2.9 |
| Net Service | 0.6 | 0.8 | 0.5 | 2.0 | 1.9 | 1.6 | 0.6 | 1.2 | 0.9 | 1.8 | 1.1 | 1.0 | 1.9 | 1.2 | 0.7 |
| *Intensive Margin* | | | | | | | | | | | | | | | |
| Increases | 25.5 | 25.5 | 25.1 | 21.9 | 21.7 | 20.6 | 27.2 | 27.0 | 25.9 | 26.6 | 26.2 | 25.1 | 26.5 | 26.2 | 24.0 |
| Decreases | −23.0 | −22.5 | −21.4 | −28.8 | −28.0 | −26.6 | −20.4 | −20.1 | −18.8 | −22.2 | −20.7 | −19.3 | −21.7 | −20.3 | −17.2 |
| Net Intensive | 2.5 | 3.0 | 3.6 | −6.9 | −6.4 | −6.0 | 6.8 | 6.9 | 7.0 | 4.4 | 5.5 | 5.8 | 4.8 | 5.9 | 6.8 |
| Total Change | 5.1 | 5.1 | 5.1 | −5.0 | −4.6 | −4.6 | 7.6 | 7.3 | 7.4 | 7.4 | 7.3 | 7.2 | 8.1 | 8.0 | 7.9 |

*Notes*: Percentage contribution of each margin to changes in total Imports calculated as simple averages of mid-point growth rates over the respective time interval (with the exception of yearly figures for 2009 to 2012).

in Table A.1.1 in the Appendix. By the same token, we cluster each country into one of six exclusive groups: countries belonging to the European Monetary Union, countries belonging to the Eurozone, countries that suffered most during the government debt crisis in the Eurozone, *i.e.* Greece, Italy, Ireland, Portugal, and Spain, denoted GIIPS, the USA as Germany's most important trading partner, and Brazil, Russia, India, and China, abbreviated BRIC, to analyze the impact of these strong expanding emerging economies. All other countries are denoted as rest the of the world, RoW. To capture different size classes, we rank firms of each industry by their total weight, *i.e.* the sum of their traded volume in $t-1$ and $t$ relative to the sum of aggregate trade volume in $t-1$ and $t$, as given in equation (1.2) and build quantiles.

We regress individual mid-point growth rates on a set of service category, country group, as well as size class dummies to disentangle the performance of each, as in Bricongne et al. (2012).[20] We apply a restricted weighted least squares regression. Given a proper formulation of the restrictions, the constrained model facilitates a meaningful interpretation of the estimated effects of each set as deviations from the weighted average of all service, country, and size class effects, respectively, and can be regarded as a measure of relative performance. We thus estimate the following equation for each period $t$:

$$\begin{aligned} &\gamma_{fcst} = \alpha_t + \delta_{st} + \delta_{ct} + \delta_{qt} + \varepsilon_{fcst} \quad \text{s.t.} \\ &\sum_n w_{nt}\delta_{nt} = 0 \quad n \in \{s, c, q\}, \end{aligned} \tag{1.3}$$

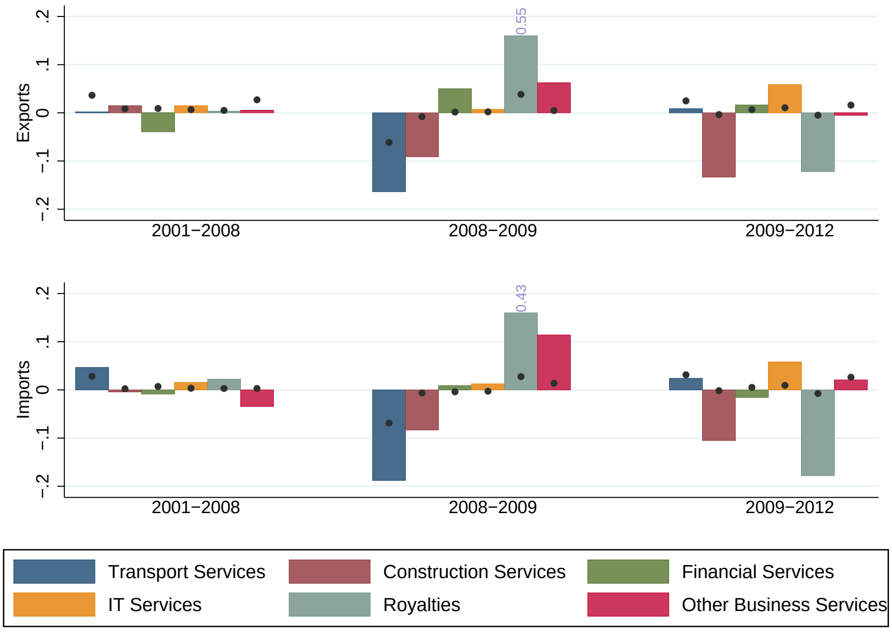
where $\alpha_t$ is a constant and $\delta_{st}$, $\delta_{ct}$, and $\delta_{qt}$ denote service categories, country groups, and quantile dummies in period $t$, respectively. Equation (1.3) restricts the weighted sum of dummies to be equal to zero, where $w_{nt}$ with $n \in \{s, c, q\}$ denotes the weight of a service, country, or size class in total exports or imports in period $t$, *i.e.* $w_{nt} = \sum_{fsc \in n} w_{fsct}$.[21]

Figure 1.3, Figure 1.4, and Figure 1.5 summarize the results for the yearly sample for service categories, country groups and size classes, respectively. Each group of bars represents the estimated contribution for the respective period. The first and third group of bars represent simple averages of estimated effects over 2001 to 2008 and 2009 to 2012, respectively, while the second group shows estimates for the years 2008 to 2009. Results for exports and imports

[20] Given that our dependent variable has two mass points around -2 and 2 the predicted values may exceed these values. One way to overcome this issue would be to estimate a fully saturated model, *i.e.* to include all possible interaction terms among the set of dummy variables, see *e.g.* Angrist and Pischke (2009). However, we abstract from this issue in the following.

[21] Since we saw in Section 3.2 that virtually all industries are engaged in services trade, including an industry effect would only be natural. However, since there are some industries that concentrate on trading a specific group of services, *e.g.* the transport industry, such an industry effect would pick up the respective service effect to some extent and *vice versa*.

Figure 1.3: Relative Performance and Absolute Contribution: Service Categories




*Notes:* Services belonging to each categories are based on the Extended Balance of Payments Services Classification (EBOPS) and listed in Table A.1.1. Each group of bars represents the estimated contribution for the respective period. Bars for the years 2001 to 2008 and 2009 to 2012 are simple averages of estimated effects. Numbers over truncated bars denote the actual value of the estimated effects. Mid-point growth of each service category is depicted by a black solid circle.

are given in the top and bottom panels, respectively. In addition to this relative performance measure, we also add the absolute contribution to services trade growth for each period depicted by a black circle.

For the years 2001 to 2008 on average, none of the service categories show significant differences in export performance relative to the average as shown in Figure 1.3. While the absolute contribution to service export growth is largest for the years 2001 to 2008, transport services are hit most during the great recession given their complementarity to goods trade. However, they contribute positively to growth from 2009 to 2010 mirroring the recovery of international goods trade. Construction services show a lower relative performance in all years after 2008. This may in some part be explained by bursts of real estate bubbles as *e.g.* in the USA, Spain or Ireland.

Financial and insurance services did not suffer relative to the average as they have performed better for exports and not significantly different than the average for imports. For Belgium, Ariu

(2016a) even finds that exports of financial and insurance services have grown by more than 20 percent. This might reflect an increase in the demand for debt and trade credit insurance in times of higher global uncertainty.

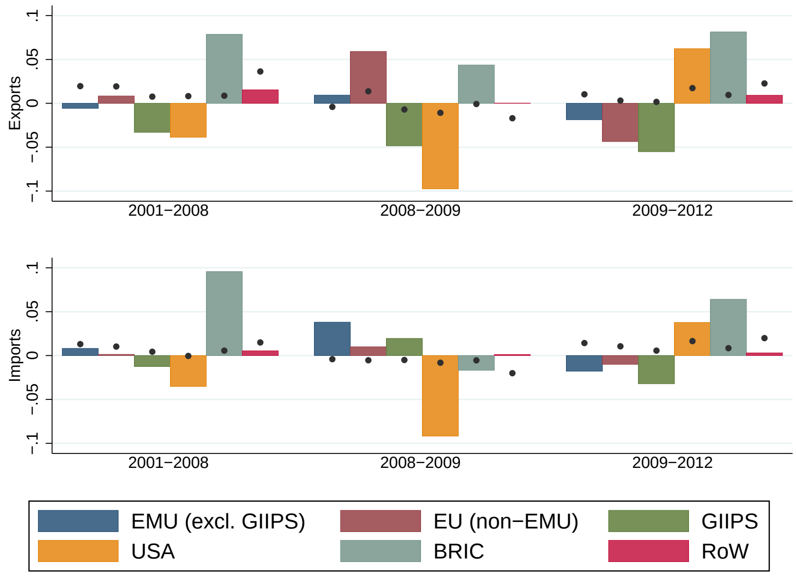
Other business services contribute positively to service export growth and performed relatively better during 2008 to 2009. This is in line with the hypotheses that on the one hand, firms outsourced backoffice services to lower costs during the trade crisis and, on the other hand, business services usually are tailored to the customers' needs and, hence, part of long-term customer-supplier relationships resulting in less cyclical demand, see Borchert and Mattoo (2010).

Exports and imports of royalties, which also include patents, licenses and other rights, strongly outperformed trade in other service categories and show the largest absolute contribution to growth during the trade collapse. Since the value of licences and other rights are usually bargained bilaterally between customer and supplier, there is no market price for these services. Hence, trade with royalties are ideally suited for transfer pricing and to shift profits between affiliated firms abroad. While there is evidence that multinational enterprises locate patents at affiliates that face lower taxes to decrease the overall corporate tax burden, see *e.g.* Karkinsky and Riedel (2012), Figure 1.3 shows that the outperformance of royalties holds for imports as well as for exports. This might suggest that in times of financial distress, liquidity is shifted abroad to cope with financial shortages.

We find the adjustment patterns of the average exporter and importer with regard to service categories to be very similar during the trade collapse and the subsequent years. Figure 1.4 reveals that this similarity also holds along the country dimension.

For the years 2001 to 2008 more mature markets like the USA and the EMU contribute to a large extent to aggregate service export and import growth, which is consistent with the findings of Bernard et al. (2009c) who document that most trade of US exporting and importing firms is conducted with higher income countries. However, trade with these countries grows less dynamically than with less saturated markets like the EU (non-EMU), which mainly consists of the new EU member states, and the emerging BRIC countries. Exports to these countries continue to grow more dynamically during 2008 to 2009 while the USA is most harmed as a trading partner both, for exports and imports reflecting the high uncertainty after the burst of the housing bubble and the following financial crisis. For imports, firms seem to concentrate more on neighboring countries, as the EMU and EU perform better than the average during that time, though absolute growth is also negative. This picture changes during the outbreak of the government debt crisis in the Eurozone, where all European countries show an underperformance. The USA, the rest of the world and especially the BRIC countries contribute more

Figure 1.4: Relative Performance and Absolute Contribution: Country Groups

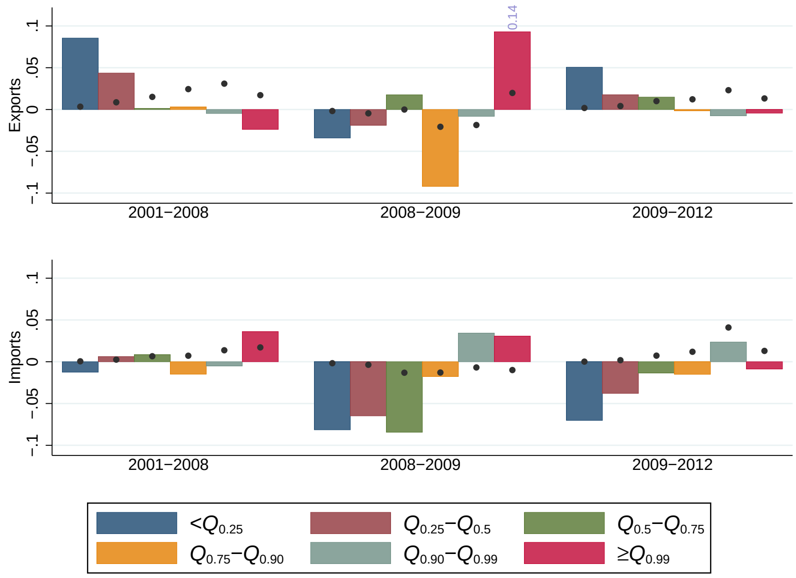



*Notes:* "GIIPS" denotes Greece, Ireland, Italy, Portugal, and Spain, "BRIC" denotes Brazil, Russia, India, and China, and "RoW" denotes the rest of the world, *i.e.* countries not part of any other group. Each group of bars represents the estimated contribution for the respective period. Bars for the years 2001 to 2008 and 2009 to 2012 are simple averages of estimated effects. Mid-point growth of each country group is depicted by a black solid circle.

than average. Trade with Greece, Italy, Ireland, Portugal, and Spain grows least dynamically in subsequent years. But since Figure 1.4 shows a similar pattern also for the years 2001 to 2008, this underperformance does not appear to be specific to the crisis.

Figure 1.5 presents the results for different size classes. While Section 1.3 showed that firms in the top percentile of the distribution clearly dominate aggregate services trade in terms of traded volume, Figure 1.5 shows for the years 2001 to 2008 for exports that they also contribute more to aggregate trade growth than firms trading only smaller volumes. However, smaller exporting firms exhibit higher growth dynamics compared to the largest firms which underperformed relative to the average firm, which is consistent with Eaton et al. (2007) and Arkolakis (2016), who also find higher growth dynamics for small goods exporters conditional upon survival. Hence, even though firms in lower quantiles often only have small sales of one service with one trading partner, they are an important contributor to export growth. However, firms with trading volumes above the 99th percentile of the distribution nevertheless have been better able to manage the trade collapse. This picture reverses with regard to relative growth dynamics for

Figure 1.5: Relative Performance and Absolute Contribution: Size Classes




*Notes:* Size classes are formed according to the sum of firms' traded volume in $t-1$ and $t$ relative to the sum of aggregate trade volume in $t-1$ and $t$ for each industry. $Q_x$ denotes the $x$-quantile. Each group of bars represents the estimated contribution for the respective period. Bars for the years 2001 to 2008 and 2009 to 2012 are simple averages of estimated effects. Numbers over truncated bars denote the actual value of the estimated effects. Mid-point growth of each size class is depicted by a black solid circle.

the years 2009 to 2012, where we find qualitatively similar patterns compared to the years 2001 to 2008.

While we also find that small importing firms suffered most and the largest importing firms perform relatively better during the trade collapse, we see a complete different picture compared to exports when looking at the years 2001 to 2008 and 2009 to 2012. Though the absolute contributions to growth of the largest and smallest firms are similar to exporting firms for the period 2001 to 2008, the top-percentile of importing firms performs relatively better, while smaller firms underperform. This lower relative performance is even more pronounced for the years 2009-2012. This is consistent with the relatively low activity of small importing firms compared to small exporting firms in the course of a year as shown in Section 1.3 as well as a relatively small net contribution of firm entry to growth that is even negative for the years 2008 onwards as shown in Table 1.4.

## 1.5 Conclusion

In this paper, we analyse how firm-level patterns shape variations in aggregate services trade in the cross-section and over time. Firms' reallocation across trading partners and services significantly contributes to overall services trade growth with the gross contribution of the reallocation within firms being larger at higher frequencies. Small exporting firms grew most dynamically with the only exception being the years 2008 to 2009 where firms trading larger volumes were better able to manage the trade collapse given their relatively better diversification. In contrast, small importing firms grew least dynamically in all years as they are relatively less active in the course of a year compared to small exporting firms. Still, these findings suggest that removing impediments to cross-border services trade, such as a deepening of the EU Single Market for Services, might help to exploit untapped growth potentials since that would alleviate foreign market entry for small, but dynamically growing firms.

# Appendix to Chapter 1

Table A.1.1: Service Categories

| **Services** |
|---|
| **Transport** |
| Receipts from freight transport by land between third counties (80) |
| Receipts from rail freight between third countries (80) |
| Receipts from inland waterway transport between third countries (80) |
| Receipts from sea freight between third countries (81) |
| Receipts from air freight between third countries (82) |
| Expenditure on sea freight in connection with German imports (210) |
| Expenditure on sea freight in connection with German exports (220) |
| Receipts and expenditure of resident airlines for air freight services in connection with Germanys external trade (225) |
| Receipts for providing pipelines/transmission through pipelines for transport through Germany (without withdrawals) (215) |
| Receipts from and expenditure on inland freight water transport including towage charges and the cost of pushing barges in connection with Germanys external trade (216) |
| Receipts from and expenditure on the transmission of electricity (217) |
| Receipts from and expenditure on the bilateral movement of rail freight (233) |
| Receipts of resident rail companies from transit (234) |
| Expenditure on freight transport by land in connection with Germanys external trade (240) |
| Payments to non-resident transport enterprises for air freight in connection with Germanys external trade (244) |
| Receipts and expenditure on transport by pipeline in connection with Germanys external trade (226) |
| Expenditure on freight transport by land between third countries (260) |
| Expenditure on rail freight between third countries (260) |
| Expenditure on inland waterway transport between third countries (260) |
| Expenditure on sea freight between third countries (260) |
| Expenditure on air freight between third countries (260) |
| Receipts from and expenditure on air freight within Germany (270) |
| Receipts from and expenditure on freight transport by land within Germany (271) |
| Receipts from and expenditure on rail freight within Germany (271) |
| Receipts from and expenditure on inland waterway transport within the economic territory (271) |
| Receipts from and payments by resident rail companies for the cross-border transport of passengers and for carrying passengers between third countries (13) |
| Receipts from and expenditure of resident airlines for the cross-border transport of passengers and for carrying passengers between third countries (14) |
| Receipts from the cross-border transport of passengers from carrying passengers between third-party countries by resident road transport companies (e.g. coach holidays) (15) |
| Receipts from cross-border passenger transportation and from inland waterway transport between third countries (15) |
| Payments to non-resident airlines for the cross-border transport of passengers and for carrying passengers between third countries (15) |
| Expenditure on the cross-border transport of passengers and on carrying passengers between third-party countries (e.g. coach holidays) (16) |
| Payments to non-resident rail companies for the cross-border transport of persons and for carrying passengers between third countries (16) |

| Services |
|---|
| Expenditure on cross-border passenger transportation and on inland waterway transport between third countries (16) |
| Expenditure on cross-border passenger transport and on sea transport between third-party countries (16) |
| Expenditure on the transport of passengers by non-resident airlines within the economic territory (20) |
| Receipts from seaports and firms operating there (300) |
| Expenditure on ancillary transport services in shipping (310) |
| Expenditure on ancillary transport services provided by road haulage companies (except fuel and other vehicle supplies) (320) |
| Payments by inland waterway enterprises for ancillary transport services (except for fuel and other ship supplies) (320) |
| Expenditure on ancillary transport services by other resident enterprises (330) |
| Receipts from ancillary transport services provided within Germany for non-resident rail operators (340) |
| Payments by resident rail companies for ancillary transport services provided by non-residents abroad (340) |
| Receipts from ancillary transport services in air transport (360) |
| Expenditure of resident airlines e.g. for take-off, landing and overflying charges as well as air traffic control (360) |
| Expenditure of resident airlines on the purchase of goods such as fuels, on-board catering and on-board sales (361) |
| Expenditure on road haulage companies for fuel and other vehicle supplies (362) |
| Receipts from supplying goods to meet the needs of foreign land craft equipment (e.g. fuel) (362) |
| Payments by inland waterway enterprises for fuel and other ship supplies (362) |
| Receipts from supplying goods to meet the need of foreign inland waterway ships (e.g. fuel) (362) |
| Receipts from freight transport by land and other forms of transport (that cannot be assigned to any other item or cannot be divided up) as well as receipts arising from refunds of freight advances in connection with Germanys external trade (370) |
| **Travel** (17) |
| **Communication services, postal services** |
| Communications services (518) |
| Postal and courier services (591) |
| **Construction services** |
| Construction sites in Germany payments made to non-resident firms in the economic territory (excluding payment for imports of goods) (570) |
| Construction sites in Germany receipts from goods deliveries to non-resident firms in the economic territory commissioned by residents (580) |
| Construction sites abroad expenditure of resident firms on construction work abroad commissioned by non-residents (580) |
| Construction sites abroad receipts from construction work abroad commissioned by non-residents (excluding export proceeds) (570) |
| **Financial and insurance services** |
| Financial services (533) |
| Resident policy holders |
| Expenditure on premiums/receipts arising from claims |
| Life insurance (400) |
| Secondary life insurance market (401) |
| Transport insurance for German imports and exports (410) |
| Other insurance transactions (420) |
| Resident insurance corporations, direct insurance contracts with non-residents |
| Premium receipts / expenditure arising from claims |
| Life insurance (440) |

| Services |
| --- |
| Transport insurance for German imports and exports (441) |
| Other insurance transactions (442) |
| Direct insurance contracts with residents |
| Expenditure arising from claims |
| Life insurance (443) |
| Transport insurance (imports and exports) (444) |
| Other insurance transactions (445) |
| Other receipts from recoveries etc. (460) |
| **IT services** (513) |
| **Royalties and license fees** |
| Patents, licences, inventions, processes (technical know-how) (502) |
| Other rights (e.g. trade marks, franchise fees, marketing rights and rights to use a name) (503) |
| Emission rights (e.g. EU allowances, assigned amount units) (507) |
| **Other business services (without merchanting)** |
| Research and development (511) |
| Engineering and other technical services as well as architects fees (512) |
| Commercial, organisational and administrative services (516) |
| Payments for other entrepreneurial work (519) |
| Advertising and trade fair expenses (540) |
| Disposal services (534) |
| Commission fees (523) |
| Subsidies to subsidiaries, branches and operating plants (530) |
| Overhead expenses (531) |
| Repairs to means of transport (560) |
| Repairs to buildings and other immovables (561) |
| Repairs to goods imported and exported for the purpose of repair (562) |
| Other services (595) |
| **Personnel, cultural, recreational services** |
| Artistic copyrights (501) |
| Film and television industry (510) |
| **Other firm-related services not allocated elsewhere** |
| Freelance work (514) |
| Personnel leasing (517) |
| Compensation of employees (521) |
| Rents/operational leasing (594) |

*Note*: The service categories (in bold) are based on the Extended Balance of Payments Services Classification (EBOPS). Numbers in brackets correspond to the coding list of the Deutsche Bundesbank.

# Chapter 2

# Volatility in Services Trade

## 2.1 Introduction

In this chapter we ask what role individual firms play in driving aggregate variations in services trade. We contribute to the recent literature that studies the role of microeconomic shocks for generating aggregate fluctuations. Gabaix (2011) finds that idiosyncratic shocks to firms do not vanish in the aggregate if the firm-size distribution is fat-tailed but can lead to considerable macroeconomic fluctuations. Carvalho (2010) and Acemoglu et al. (2012) show that microeconomic shocks may propagate through the economy via input-output linkages and contribute to aggregate volatility. Our paper also adds to the recent work by Kramarz et al. (2015) who also point to the importance of firms' diversification for aggregate volatility.[1]

Our analysis of the drivers of services trade volatility is closely related to di Giovanni et al. (2014) who use yearly data of French firms' sales at home and abroad. We follow the authors by decomposing services trade growth into shocks at the aggregate level, a macro-meso component, and an idiosyncratic component that captures shocks stemming from firms' individual trade relationships.

We show that, at yearly frequency, idiosyncratic shocks stemming from firms' trade relationships are relatively more important for explaining overall services trade volatility than macro-meso-level shocks, though their impact is still sizable, which is consistent with the findings of di Giovanni et al. (2014). However, we find differences across frequencies. While the relative contribution of the macro-meso component is increasing at monthly frequency, suggesting that it is more driven by temporary shocks, such as demand shocks that are more important in the

[1] Kramarz et al. (2015) focus on yearly information on French firms' individual trade networks. While Kramarz et al. (2015) have very disaggregated information on firms' sales vis-à-vis individual buyers, we use information that is more disaggregated along the time dimension.

short run, the absolute and relative contribution of the idiosyncratic component is decreasing at higher frequencies. Since transactions are lumpy within firms and firms' trade portfolios are also intertemporally imperfectly diversified, as noted above, idiosyncratic volatility increases from monthly to yearly frequency.

At yearly frequency, we find that shocks stemming from the extensive margin to only play a minor role in explaining aggregate services trade volatility compared to shocks stemming from the intensive margin. Though the impact of the intensive margin is still larger, the relative contribution of the extensive margin increases at monthly frequency given the increase in gross contributions of entering and exiting firms as well the reallocation of resources across trade relationships within established firms to overall services trade growth at higher frequencies.

Given their importance for aggregate volatility, we decompose fluctuations stemming from idiosyncratic shocks into a direct component, *i.e.* shocks to firms' individual trade relationships alone, and network effects that arise from input-output linkages leading to comovement between firms. Consistent with di Giovanni et al. (2014), we find that at yearly frequency network effects explain the lion share of idiosyncratic volatility and closely resemble the evolution of idiosyncratic volatility over time. However, at monthly frequency, the relative contribution of the direct effect more than doubles while the impact of network effects, though still being larger, decreases. Hence, we find that the direct component and network effects are not separated channels, but instead mutually belong together, as recently argued by Gabaix (2016). In the short run, shocks to firms' individual trade relationships alone matter. In the course of a year, comovement between firms becomes more important indicating that these individual shocks are propagated through firm-to-firm linkages which increase the impact of network effects at yearly frequency.

Finally, we also add to the literature by showing that the diversification within firms matters for aggregate fluctuations. We consolidate shocks stemming from individual trade relationships within firms leaving as only source of variation shocks to individual firms' total trade. When taking firms' diversification explicitly into account, we find overall and idiosyncratic volatility to be roughly 40 percent smaller compared to the corresponding undiversified volatilities at yearly frequency, while the relative contribution of idiosyncratic shocks is by and large the same. This complements recent findings by Kramarz et al. (2015), who use a different decomposition methodology than we do but find that shocks to seller-buyer relationships are important for overall volatility. Since idiosyncratic volatility now increases only very modestly from monthly to yearly frequency, the consolidation of shocks within firms diversifies most of the lumpiness of firms' transactions intertemporally.

The paper is structured as follows. Section 2.2 briefly describes our data. Section 2.3 shows firms' trade portfolio allocation in terms of traded services partner countries and transactions. Section 2.4 shows how the dispersion of activities within firms lead to aggregate variations in services trade volatility. Section 2.5 concludes.

## 2.2 Data

We use the Statistics on International Trade in Services (SITS) compiled by the Deutsche Bundesbank which provides comprehensive information on Germany's trade in services at the transaction-level, covering the universe of German services exporters and importers. Incoming or outgoing payments of services trade flows that exceed 12,500 Euro (or the equivalent in another currency) need to be reported with type of services traded and destination or source country. However, the data also entails traded volumes below this reporting threshold. One additional virtue of the data is its availability at monthly frequency. We use the SITS for the years 2001 to 2012. A detailed description is given in Chapter 1.

## 2.3 Within-firm Distribution of Traded Services, Destinations and Transactions

In this section, we look at firms' trade portfolios in greater detail. Tables 2.1 to 2.3 show the distribution of services, trading partners and transactions within firms. The tables present the shares of volumes traded of an average firm attributable to the first, second, third, etc. most important service, market, and transaction, respectively. The last two columns show the ordinary and the normalised Herfindahl indeces of within-firm shares as measures of diversification. While the ordinary Herfindahl index gives the overall diversification due to the extensive and intensive margin, the normalised Herfindahl index reflects diversification along the intensive margin only, taken as given the number of services, countries or transactions.[2]

Tables 2.1 and 2.2 show that there is a strong concentration on "core" services and trading partners. A firm that exports two services allocates more than 80 percent of its sales to the most important one. The average share is decreasing for firms exporting more services, but still amounts to 60 percent if exactly ten services are exported. The average share of sales of the second, third etc. most important service is exponentially decreasing, with an average share of only 0.1 percent on the tenth service exported. A similar concentration also holds among trading

[2] The ordinary Herfindahl index is given by $HI = \sum_n (x_{fn}/x_f)^2$ and ranges from $1/N_n$ to 1 for $n \in \{s, c, tr\}$, where $N_n$ is the number of services, countries or transactions. The normalised Herfindahl index is given by $HI^{norm} = (HI - 1/N_n)/(1 - 1/N_n)$ for $n \in \{s, c, tr\}$ and ranges from 0 to 1, with $HI^{norm} = 1$ for $N_n = 1$.

Table 2.1: Heterogeneity Within Firms, Services Traded, Averages for 2001-2012

| | Rank of service | | | | | | Trade | Within-firm | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 10 | volume | $HI$ | $HI^{norm}$ |
| *Percent of exports* | | | | | | | | | |
| Exact 2 services | 81.37 | 18.63 | – | – | – | – | 11,264 | 0.74 | 0.49 |
| Exact 3 services | 74.22 | 19.44 | 6.34 | – | – | – | 20,223 | 0.65 | 0.47 |
| Exact 4 services | 69.98 | 19.88 | 7.37 | 2.77 | – | – | 25,244 | 0.59 | 0.46 |
| Exact 5 services | 67.73 | 20.22 | 7.70 | 3.15 | 1.20 | – | 36,003 | 0.56 | 0.45 |
| Exact 10 services | 59.90 | 20.76 | 9.06 | 4.52 | 2.48 | 0.13 | 170,953 | 0.46 | 0.40 |
| *Percent of imports* | | | | | | | | | |
| Exact 2 services | 77.80 | 22.20 | – | – | – | – | 2,655 | 0.70 | 0.40 |
| Exact 3 services | 70.06 | 21.46 | 8.48 | – | – | – | 4,042 | 0.60 | 0.40 |
| Exact 4 services | 65.71 | 21.10 | 9.08 | 4.12 | – | – | 5,284 | 0.54 | 0.39 |
| Exact 5 services | 62.45 | 21.08 | 9.53 | 4.67 | 2.27 | – | 6,549 | 0.50 | 0.38 |
| Exact 10 services | 54.21 | 20.44 | 10.53 | 5.92 | 3.61 | 0.27 | 22,512 | 0.40 | 0.34 |

*Notes*: This table shows the average within-firm shares (in percent) of exports/imports for those services ranked first, second, third, etc. and firms that trade exactly two, three, four, etc. services. Average trade volumes are rounded and reported in thousand Euro. $HI$ and $HI^{norm}$ denote the usual and normalised within-firm Herfindahl index, respectively (see footnote 2).

partners. These figures are remarkably similar to those found by Breinlich and Criscuolo (2011) for the UK.[3]

Clearly, the ordinary Herfindahl index, and hence, the concentration of firms' portfolios, is decreasing in the number of services exported and trading partners. Controlling for the number of services exported and the number of trading partners, the normalised Herfindahl reveals that better diversification of larger firms is not only due to the higher number of services traded and countries served *per se*, but also due to the allocation of trade volumes within firms' portfolios. Still, firms that export to 25 countries have an ordinary Herfindahl of 0.2 while an even split of their respective export activity across destination countries would imply a value of 0.04.

Table 2.3 shows quantitatively very similar distributions of within-firm shares of export transactions with almost identical Herfindahl indeces compared to the diversification among trading partners. In addition to yearly averages, Table A.2.1 in the Appendix presents the within-firm distribution of transactions for an average month. We find almost identical patterns. If they do become active in a month, they do not split their sales equally, but concentrate on most important transactions. Thus, the lumpiness documented in Alessandria et al. (2010) for disaggregated exported goods in the USA, also holds within firms. Despite their low activity,

[3]This finding is also in line with recent evidence by Kramarz et al. (2015). Using data on French firms' trade networks, they show that the concentration of goods sales also holds among clients of individual firms.

Table 2.2: Heterogeneity Within Firms, Trading Partners, Averages for 2001-2012

| | Rank of country | | | | | | | Trade | Within-firm | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 10 | 25 | volume | $HI$ | $HI^{norm}$ |
| *Percent of exports* | | | | | | | | | | |
| Exact 2 countries | 77.81 | 22.19 | – | – | – | – | – | 2,481 | 0.70 | 0.41 |
| Exact 3 countries | 68.25 | 22.48 | 9.27 | – | – | – | – | 3,624 | 0.58 | 0.37 |
| Exact 4 countries | 62.15 | 22.45 | 10.27 | 5.12 | – | – | – | 4,007 | 0.51 | 0.34 |
| Exact 5 countries | 58.44 | 21.64 | 10.75 | 5.93 | 3.25 | – | – | 4,896 | 0.46 | 0.32 |
| Exact 10 countries | 46.47 | 19.48 | 11.37 | 7.44 | 5.13 | 0.84 | – | 11,024 | 0.33 | 0.25 |
| Exact 25 countries | 33.85 | 16.08 | 10.27 | 7.54 | 5.81 | 2.14 | 0.11 | 64,858 | 0.20 | 0.17 |
| *Percent of imports* | | | | | | | | | | |
| Exact 2 countries | 75.47 | 24.53 | – | – | – | – | – | 737 | 0.67 | 0.35 |
| Exact 3 countries | 66.21 | 23.36 | 10.43 | – | – | – | – | 1,075 | 0.55 | 0.33 |
| Exact 4 countries | 60.73 | 22.61 | 10.96 | 5.69 | – | – | – | 1,492 | 0.49 | 0.31 |
| Exact 5 countries | 56.63 | 22.11 | 11.33 | 6.36 | 3.56 | – | – | 1,970 | 0.44 | 0.30 |
| Exact 10 countries | 45.96 | 20.16 | 11.64 | 7.52 | 5.07 | 0.77 | – | 6,167 | 0.32 | 0.24 |
| Exact 25 countries | 35.40 | 16.16 | 10.55 | 7.47 | 5.77 | 2.01 | 0.09 | 29,656 | 0.21 | 0.18 |

*Notes*: This table shows the average shares (in percent) of exports and imports for those trading partners ranked first, second, third, etc. and firms that trade with exactly two, three, four, etc. countries. Average trade volumes are rounded and reported in thousand Euro. $HI$ and $HI^{norm}$ denote the usual and normalised within-firm Herfindahl index, respectively (see footnote 2).

one still might expect that firms improve the diversification of their trade portfolios in the course of a year. However, compared to Table 2.3, the Herfindahl indeces are even slightly smaller at monthly frequency. Hence, firms are not only imperfectly diversified in a given month but also intertemporally as their trading activity is infrequent.

Results for importing firms with the same number of services, countries and transactions as exporters are by and large the same. If anything, despite trading lower volumes, they are slightly better diversified than exporters.

## 2.4 Volatility in Services Trade

In this section we analyse, how fluctuations in service trade growth themselves are driven by changes in firm-level activities. To this end, we proceed in four steps. First, we decompose service trade growth into shocks at the aggregate- and firm-level following the recent contribution by di Giovanni et al. (2014). Second, we analyse the contribution of the extensive and intensive margin to overall service trade volatility, taking advantage of mid-point growth rates as our measure for change, see Davis and Haltiwanger (1992). Third, we disentangle the sources of fluctuations

Table 2.3: Heterogeneity Within Firms, Transactions, Averages for 2001-2012

| | Rank of transaction | | | | | | | Trade | Within-firm | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 10 | 25 | volume | $HI$ | $HI^{norm}$ |
| *Percent of exports* | | | | | | | | | | |
| Exact 2 transactions | 76.89 | 23.11 | – | – | – | – | – | 2,307 | 0.69 | 0.39 |
| Exact 3 transactions | 67.55 | 22.82 | 9.64 | – | – | – | – | 3,275 | 0.57 | 0.36 |
| Exact 4 transactions | 61.31 | 22.73 | 10.62 | 5.35 | – | – | – | 3,894 | 0.49 | 0.33 |
| Exact 5 transactions | 57.10 | 22.26 | 11.11 | 6.13 | 3.39 | – | – | 3,926 | 0.44 | 0.31 |
| Exact 10 transactions | 45.50 | 19.44 | 11.56 | 7.65 | 5.26 | 0.91 | – | 8,976 | 0.32 | 0.24 |
| Exact 25 transactions | 33.11 | 16.03 | 10.45 | 7.56 | 5.82 | 2.13 | 0.14 | 27,734 | 0.20 | 0.16 |
| *Percent of imports* | | | | | | | | | | |
| Exact 2 transactions | 73.55 | 26.45 | – | – | – | – | – | 1,200 | 0.65 | 0.31 |
| Exact 3 transactions | 64.11 | 24.20 | 11.69 | – | – | – | – | 969 | 0.53 | 0.30 |
| Exact 4 transactions | 58.43 | 23.10 | 11.87 | 6.60 | – | – | – | 1,116 | 0.46 | 0.28 |
| Exact 5 transactions | 54.72 | 22.17 | 11.88 | 7.01 | 4.22 | – | – | 1,347 | 0.42 | 0.27 |
| Exact 10 transactions | 44.39 | 19.88 | 11.72 | 7.63 | 5.30 | 1.04 | – | 3,203 | 0.30 | 0.23 |
| Exact 25 transactions | 34.13 | 16.06 | 10.53 | 7.54 | 5.76 | 2.02 | 0.16 | 14,776 | 0.20 | 0.17 |

*Notes*: This table shows the average shares (in percent) of exports and imports for those transactions ranked first, second, third, etc. and firms that engage exactly two, three, four, etc. times in service-country trade in a given year. Average trade volumes are rounded and reported in thousand Euro. $HI$ and $HI^{norm}$ denote the usual and normalised within-firm Herfindahl index, respectively (see footnote 2).

stemming from idiosyncratic shocks by decomposing idiosyncratic volatility into shocks specific to individual firms' trade relationships alone and comovement across firms. Finally, we asses the role played by the diversification among trade relationships within firms for the variation of growth rates.

### 2.4.1 Shocks at the Macro-Meso- and Firm-Level

Setting up a model along the lines of Melitz (2003) and Eaton et al. (2011), di Giovanni et al. (2014) decompose aggregate sales volatility of French firms into an aggregate and a firm-specific component. The individual mid-point growth rate of sales $x_{fcst}$ of firm $f$ that is trading service $s$ with country $c$ at time $t$ can be decomposed as:

$$\gamma_{fsct} = \alpha_t + \delta_{ct} + \delta_{it} + \delta_{sct} + \varepsilon_{fsct}\,, \tag{2.1}$$

with $\gamma_{fcst} = 2\,(x_{fcst} - x_{fcst-1})\,/\,(x_{fcst} + x_{fcst-1})$. Equation (2.1) decomposes individual growth rates of exports and imports into two effects that reflect shocks at the macro- and meso-level, respectively, as well as shocks stemming from firms' individual trade relationships. The macro-level is given by a time effect, $\alpha_t$, that captures a domestic aggregate shock common to all firms (a Germany-specific shock) and a shock specific to the country German firms are trading with, $\delta_{ct}$. The meso-level comprises an industry-specific shock, $\delta_{it}$, and a service-country-specific shock that is supposed to capture demand shocks for individual services in one country, $\delta_{sct}$. The idiosyncratic component captures shocks to firms' individual trade relationships and is given by the residual, $\varepsilon_{fsct}$. The decomposition in di Giovanni et al. (2014) is based on log-differences which cannot be applied to mid-point growth rates. Hence, our results should be seen as an approximation to their model.

As noted in the previous section, the coefficients in the above regression cannot be identified separately if estimated in one framework unless some effects are dropped or other restrictions are imposed. Variations of the estimated coefficients would then have to be interpreted relative to the omitted base effect. We follow di Giovanni et al. (2014) and subsume time, country, demand, and industry effects into one set of dummy variables, $\delta_{scit}$, that captures all effects at the macro- and meso-level and enables us to disentangle macro-meso- from idiosyncratic shocks.[4] The joint impact of the effects remains the same regardless of the identification strategy. We thus run the following regression:

$$\gamma_{fsct} = \delta_{scit} + \varepsilon_{fsct} \, .$$

Weighting the individual components with their respective weights and summation leads to aggregate trade growth in period $t$:

$$\gamma_t = \sum_{fsc} w_{fsct} \left( \delta_{scit} + \varepsilon_{fsct} \right) = \sum_{sci} w_{scit} \delta_{scit} + \sum_{fsc} w_{fsct} \varepsilon_{fsct} \tag{2.2}$$

with $w_{fcst} = \left( x_{fcst} + x_{fcst-1} \right) / \left( \sum_{fcs} x_{fcst} + \sum_{fcs} x_{fcst-1} \right)$. A natural way to asses the impact of shocks at the macro-meso- and firm-level on service trade volatility would be to decompose the variance based on equation (2.2) into the sum of the variances of the weighted components and the covariance between them:

$$\text{Var}\left(\gamma_t\right) = \text{Var}\left( \sum_{sci} w_{scit} \delta_{scit} \right) + \text{Var}\left( \sum_{fsc} w_{fsct} \varepsilon_{fsct} \right) + \text{Cov}\left( \sum_{sci} w_{scit} \delta_{scit}, \sum_{fsc} w_{fsct} \varepsilon_{fsct} \right)$$

However, decomposing the variance in this way makes it infeasible to analyze the contribution of shocks at the macro-meso- and firm-level alone, since the above decomposition links the contribution of shocks with the attached weights. To get a better understanding about how macro-meso

[4] As shown in the previous chapter, it is important to distinguish a firm's industry from the services it is trading. Hence, we slightly augment the framework by di Giovanni et al. (2014) to account for potential industry shocks. Even though the sector of a firm may coincide with the services it is trading, *e.g.* in the case of transport services, this is innocuous as we subsume all effects at the macro-meso level anyway.

and idiosyncratic components influence fluctuations in aggregate service trade growth, we treat the weights as non-stochastic and keep them constant at each point in time, as in Carvalho and Gabaix (2013) and di Giovanni et al. (2014). Aggregate service trade growth at time $t$ with weights being fixed at their time $\tau$ value can then be written as:

$$\gamma_{t|\tau} = \sum_{sci} w_{sci\tau}\delta_{scit} + \sum_{fsc} w_{fsc\tau}\varepsilon_{fsct} \,.$$

We thus end up with $T \times T$ growth rates, where $T$ is the total number of periods. The variance can then be decomposed as

$$\begin{aligned} \sigma^2_{\gamma\tau} &= \sigma^2_{\delta\tau} + \sigma^2_{\varepsilon\tau} + \text{Cov}_\tau, \text{ with} \qquad (2.3)\\ \sigma^2_{\delta\tau} &= \text{Var}\left(\sum_{sci} w_{sci\tau}\delta_{scit}\right), \\ \sigma^2_{\varepsilon\tau} &= \text{Var}\left(\sum_{fsc} w_{fsc\tau}\varepsilon_{fsct}\right), \text{ and} \\ \text{Cov}_\tau &= \text{Cov}\left(\sum_{sci} w_{sci\tau}\delta_{scit}, \sum_{fsc} w_{fsc\tau}\varepsilon_{fsct}\right). \end{aligned}$$

The left hand side of equation (2.3), $\sigma^2_{\gamma\tau}$, corresponds to the variance of actual mid-point growth rates. Variances of macro-meso- and firm-level shocks are denoted by $\sigma^2_{\delta\tau}$ and $\sigma^2_{\varepsilon\tau}$, respectively. The last term on the right hand of equation (2.3), $\text{Cov}_\tau$, is the covariance between the two levels.[5]

Table 2.4 presents the results of this decomposition for monthly, quarterly and yearly frequencies. The first column of each block of frequencies presents averages of the standard deviations over the sample. The second column presents averages of standard deviations relative to aggregate volatility. Results for exports and imports are given in the top and bottom panel, respectively.

As can be seen from Table 2.4, idiosyncratic shocks stemming from firms' export relationships are relatively more important for explaining actual service trade volatility than macro-meso-level shocks, though their impact is still sizable. At yearly frequency, the relative standard deviations of idiosyncratic shocks and the macro-meso-level are 0.86 and 0.46, respectively. These findings are quantitatively remarkably similar to those of di Giovanni et al. (2014) for French goods exporters.[6] However, Table 2.4 also shows that there are differences across frequencies.

[5] $\sigma^2_{\gamma\tau}$, $\sigma^2_{\delta\tau}$ and $\sigma^2_{\varepsilon\tau}$ can be seen as the variance of $T$ realizations of $\gamma_{t|\tau}$, $\sum_{sci} w_{scit}\delta_{scit}$, and $\sum_{fsc} w_{fsct}\varepsilon_{fsct}$, respectively. di Giovanni et al. (2014) technically show how $\sigma^2_{\gamma\tau}$ relates to aggregate growth volatility.

[6] Since the decomposition in di Giovanni et al. (2014) is based on log-changes, it captures changes in established trade relationships of incumbent firms only. They use mid-point growth rates as a robustness check and find the relative standard deviation of idiosyncratic shocks to be of similar magnitude for all French firms in their sample.

Table 2.4: Contribution to Service Trade Volatility: Macro-Meso and Idiosyncratic Shocks

| | monthly | | quarterly | | yearly | |
|---|---|---|---|---|---|---|
| | SD | Rel. SD | SD | Rel. SD | SD | Rel. SD |
| *services exports* | | | | | | |
| Actual | 0.1384 | 1.0000 | 0.1588 | 1.0000 | 0.1985 | 1.0000 |
| Macro-Meso | 0.0919 | 0.7031 | 0.0828 | 0.5615 | 0.0812 | 0.4561 |
| Idiosyncratic | 0.1128 | 0.8059 | 0.1366 | 0.8489 | 0.1730 | 0.8569 |
| *services imports* | | | | | | |
| Actual | 0.1282 | 1.0000 | 0.1560 | 1.0000 | 0.2061 | 1.0000 |
| Macro-Meso | 0.0912 | 0.7474 | 0.0838 | 0.5721 | 0.0863 | 0.4578 |
| Idiosyncratic | 0.1107 | 0.8681 | 0.1378 | 0.8902 | 0.1828 | 0.8936 |

*Notes*: This table shows the contribution of macro-meso and idiosyncratic shocks to actual services trade volatility for monthly, quarterly and yearly frequencies according to the decomposition in equation (2.3). The first column of each block of frequencies presents averages of the standard deviations over the sample (*i.e.* $1/T \sum \sigma_{n\tau}$ for $n \in \{\gamma, \delta, \varepsilon\}$). The second column presents averages of standard deviations relative to aggregate volatility (*i.e.* $1/T \sum \sigma_{n\tau}/\sigma_{\gamma\tau}$ for $n \in \{\gamma, \delta, \varepsilon\}$). Results for exports and imports are given in the top and bottom panel, respectively.

Though the absolute standard deviation of shocks at the macro-meso-level stays by and large the same across frequencies, their relative impact increases by more than 60 percent to 0.70 at monthly frequency. This indicates that, on average, the macro-meso component is more driven by temporary shocks, such as demand shocks, that are more important at shorter horizons.

In contrast, the absolute and relative idiosyncratic volatility decreases at higher frequencies. There are two opposing effects driving this result. On the one hand, idiosyncratic volatility should increase in the very short run, since the gross contribution of firms' portfolio reallocation to growth increases at monthly frequency, as shown in the previous chapter. On the other hand, if firms do become active during a year, their sales are concentrated on most important transactions, as shown in Section 2.3. In addition, given that firms trade is infrequent in the course of a year, idiosyncratic volatility should increase from monthly to yearly frequency. Table 2.4 shows that this latter effect dominates.

Table 2.4 shows quantitative similar results for the absolute and relative contribution of shocks stemming from the macro-meso-level and firms' individual trade relationships for imports.

The evolution of volatilities for the quarterly sample is depicted in Figure 2.1.[7] Estimates for services exports and imports are given in the left and right panel, respectively. Shaded areas correspond to the 95 percent confidence interval based on an overlapping block bootstrap.[8] The

[7]We stick to quarterly frequency here to be more in line with standard business cycle analysis.

[8]di Giovanni et al. (2014) show that results based on analytical and bootstrapped standard errors are very

Figure 2.1: Contribution of Macro-Meso and Idiosyncratic Shocks to Quarterly Service Trade Volatility

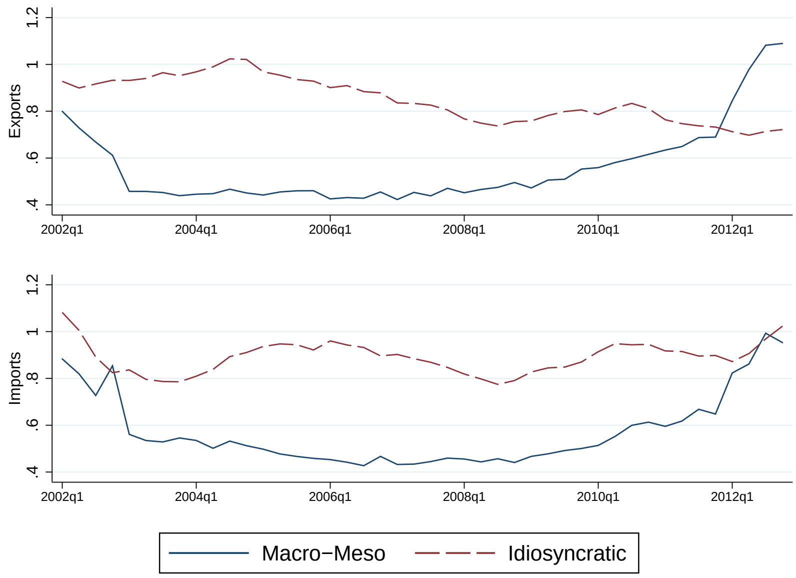

*Notes*: This figure shows the estimated contribution of shocks to the macro-meso- and firm-level according to equation (2.3). Estimates for services exports and imports are given in the left and right panel, respectively. Shaded areas correspond to the 95 percent confidence interval based on overlapping block bootstraps.

volatility of idiosyncratic shocks to firms' trade relationships closely resembles the behaviour of actual service trade volatility, whereas the volatility of shocks at the macro-meso-level remains almost constant over the sample period, which again is very similar to the findings of di Giovanni et al. (2014) for yearly French firms' sales.

There is no pronounced effect of the Great Recession or the Eurozone sovereign debt crises in either series. Figure 2.2 shows the relative contribution of shocks at the macro-meso-level and idiosyncratic shocks to firms' trade relationships to actual service trade volatility over time. Results for exports and imports are in the top and bottom panel, respectively. We would expect shocks at the macro-meso-level to become more important for aggregate fluctuations during the crisis period after 2007 due to increased policy interventions. Figure 2.2 reveals, that there is an increase in the relative importance of macro-meso-level shocks since 2007. While the relative standard deviation of the idiosyncratic component is decreasing after 2005 for exports and 2006

similar. The bootstrap is based on the series of $\gamma_{t|\tau}$, $\sum w_{sci\tau}\delta_{scit}$ and $\sum w_{fsc\tau}\varepsilon_{fsct}$. We draw 10,000 overlapping blocks with replacement from each series. The blocksize is determined by the nearest integer to $T^{1/3}$, *i.e.* 4 for quarterly frequency.

Figure 2.2: Relative Contribution of Macro-Meso and Idiosyncratic Shocks




*Notes:* This figure shows the volatility of shocks at the macro-meso-level shocks and idiosyncratic shocks relative to actual services trade volatility given by $\sigma_{\delta\tau}/\sigma_{\gamma\tau}$ and $\sigma_{\varepsilon\tau}/\sigma_{\gamma\tau}$ for quarterly data. The series for services exports and imports are given in the top and bottom panel, respectively.

for imports, it again increases for the years 2008 to 2010. Hence, even though actual and firm-specific volatility are decreasing in absolute terms after 2007, firm-level adjustments during and in the aftermath of the trade collapse in 2008 to 2009 increased its relative contribution during that time.

### 2.4.2 Extensive and Intensive Margin

As the previous chapter showed that entering and exiting firms as well as service- and country-switching within incumbent firms contribute to a considerable part to aggregate service trade growth, we further analyse their impact for service trade volatility. Since our underlying measure of change is based on mid-point growth rates, we can disentangle the impact of the extensive and intensive margin on the fluctuations of service trade based on individual growth rates. More specifically, we decompose the actual variance into the variation of growth due to changes in the extensive and intensive margin, respectively, as well as a covariance term between the two:

$$\sigma_{\gamma\tau}^2 = \text{Var}\left(\sum_{fsc\in E} w_{fsc\tau}\gamma_{fsct}\right) + \text{Var}\left(\sum_{fsc\in I} w_{fsc\tau}\gamma_{fsct}\right) + \text{Cov}_\tau \,,$$

Table 2.5: Contribution to Service Trade Volatility: Extensive and Intensive Margin

| | monthly | | quarterly | | yearly | |
|---|---|---|---|---|---|---|
| | SD | Rel. SD | SD | Rel. SD | SD | Rel. SD |
| *services exports* | | | | | | |
| Actual | 0.1384 | 1.0000 | 0.1588 | 1.0000 | 0.1985 | 1.0000 |
| Extensive Margin | 0.0241 | 0.1767 | 0.0185 | 0.1190 | 0.0138 | 0.0722 |
| Intensive Margin | 0.0584 | 0.4345 | 0.0726 | 0.4667 | 0.1116 | 0.5732 |
| *services imports* | | | | | | |
| Actual | 0.1282 | 1.0000 | 0.1560 | 1.0000 | 0.2061 | 1.0000 |
| Extensive Margin | 0.0212 | 0.1686 | 0.0178 | 0.1140 | 0.0137 | 0.0651 |
| Intensive Margin | 0.0535 | 0.4268 | 0.0730 | 0.4770 | 0.1138 | 0.5591 |

*Notes*: This table shows actual volatility for the full sample, as well as for subsamples of growth rates belonging to extensive and intensive margin, respectively, for monthly, quarterly and yearly frequencies. The first column of each block of frequencies presents averages of the standard deviations over the sample. The second column presents averages of standard deviations relative to actual volatility for the full sample. Results for exports and imports are given in the top and bottom panel, respectively.

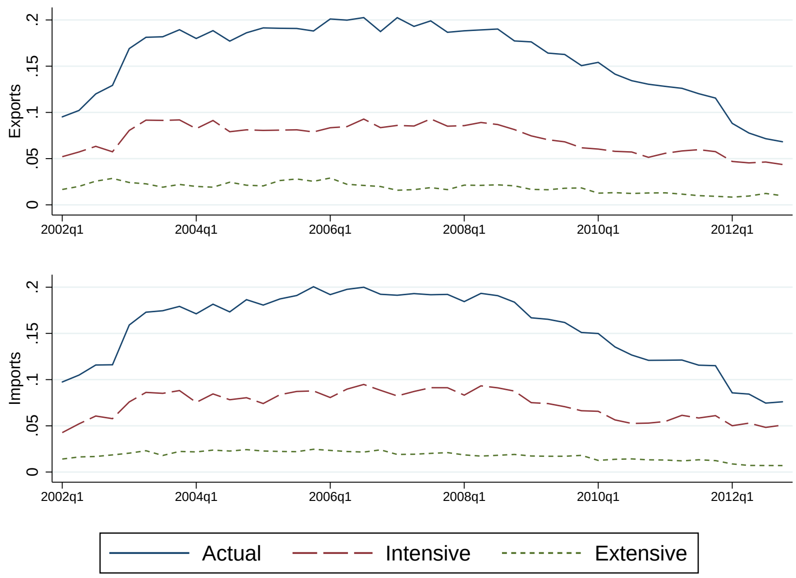
where $E$ and $I$ denote the set of individual growth rates belonging to the extensive and intensive margin, respectively.

Table 2.5 shows the resulting standard deviation of actual service trade and the extensive and intensive margin as well as the respective standard deviation relative to actual service trade volatility. The evolution of volatilities is depicted in Figure 2.3. As can be seen, the intensive margin is more important for actual service trade volatility. At yearly frequency, the intensive margin explains more than 55 percent, whereas the extensive margin only explains 7 percent of actual service export and import volatility, respectively.[9] However, the relative standard deviation of growth rates due to changes in the extensive margin increases at higher frequencies and the impact of the intensive margin decreases. While the contribution of the intensive margin is still larger with 0.43, the relative standard deviation of the extensive margin more than doubles to 0.18 and 0.17 at monthly frequency for exports and imports, respectively, which is consistent with increasing gross contributions of the reallocation of resources across trading partners and services within established firms to growth at higher frequencies as shown in the the previous chapter.

We find quantitatively very similar results when we decompose idiosyncratic shocks to firms'

[9]Decomposing aggregate sales growth of French firms, di Giovanni et al. (2014) also find the intensive margin to be more important than the extensive margin, but report somewhat larger numbers.

Figure 2.3: Contribution of the Extensive and Intensive Margin




*Notes:* This figure shows the contribution of the extensive and intensive margin for actual services trade for quarterly data. Series for services exports and imports are given on the top and bottom panel, respectively.

trade relationships into extensive and intensive components, see Table A.2.2.[10] The intensive margin contributes most to idiosyncratic volatility with the extensive margin becoming more important at higher frequencies.

### 2.4.3 Idiosyncratic Shocks and Network Effects

Given the importance of shocks to firms' trade relationships for aggregate volatility as shown in Section 2.4.1, we further analyse two potential channels through which idiosyncratic shocks may matter for the aggregate. Gabaix (2011) shows that, if the firm size distribution is fat-tailed, idiosyncratic shocks to large firms may lead to considerable aggregate fluctuations.[11]

[10] In this case, firm-specific volatility can be decomposed as:

$$\sigma^2_{\varepsilon\tau} = \text{Var}\left(\sum_{fsc\in E} w_{fsc\tau}\varepsilon_{fsct}\right) + \text{Var}\left(\sum_{fsc\in I} w_{fsc\tau}\varepsilon_{fsct}\right) + \text{Cov}\left(\sum_{fsc\in E} w_{fsc\tau}\varepsilon_{fsct}, \sum_{fsc\in I} w_{fsc\tau}\varepsilon_{fsct}\right).$$

[11] Gabaix (2011) shows that if the firm size distribution is thin-tailed and the Central Limit Theorem applies, shocks to individual firms decay very fast at a rate $1/\sqrt{N_f}$, where $N_f$ is the number of firms. If, in contrast, firm size is distributed according to a power law, shocks decay much more slowly, *e.g.* at rate $1/\ln N_f$ in case of a Zipf distribution, giving rise for idiosyncratic shocks of large firms to matter for aggregate fluctuations.

For the USA, he finds idiosyncratic shocks to the 100 largest firms to account for roughly one third of overall GDP volatility. Canals et al. (2007) and di Giovanni and Levchenko (2012) also provide evidence for the role of idiosyncratic shocks to large firms in open economy settings. Another reason why micro-level shocks may matter for aggregate fluctuations is that firms do not act as isolated entities but are embedded in complex production networks. The argument is similar to the one above: If input-output linkages between firms are not balanced but fat-tailed distributed, *i.e.* some few firms play a dominant role in supplying inputs to others, firm-specific idiosyncratic shocks may propagate through the network leading to aggregate fluctuations as shown by Acemoglu et al. (2012) and Carvalho (2014). Since the volume of firms' individual trade flows and the number of trade relationships are fat-tailed distributed, both arguments may matter for explaining overall idiosyncratic volatility.

In order to assess the contribution of both channels, we follow Carvalho and Gabaix (2013) and di Giovanni et al. (2014) and decompose the volatility of shocks to firms' trade relationships as:

$$\begin{aligned} \sigma_{\varepsilon\tau}^2 &= \sum_{fsc} w_{fsc\tau}^2 \mathrm{Var}\left(\varepsilon_{fsct}\right) + \sum_{fsc} \sum_{\substack{f' \neq f \\ s' \neq s \\ c' \neq c}} w_{fsc\tau} w_{f's'c'\tau} \mathrm{Cov}\left(\varepsilon_{fsct}, \varepsilon_{f's'c't}\right) \\ &= Direct_\tau^2 + Link_\tau^2 \end{aligned} \tag{2.4}$$

The first term on the right hand side, $Direct_\tau^2$, is the weighted sum of individual variances of shocks to firms' trade relationships, and captures the impact of shocks to individual trade relationships alone. The second term on the right hand side of equation (2.4), $Link_\tau^2$, is the weighted sum of covariances of shocks to trade relationships and captures the comovement across firms.

The resulting decomposition is summarized in Table 2.6 and graphically depicted in Figure 2.4. For monthly, quarterly and yearly frequencies, the first column in Table 2.6 shows the average standard deviation of the firm-specific idiosyncratic component, the *Direct* component, and the volatility due to comovement, the *Link* component. The second and third column report the average standard deviation of each component relative to total idiosyncratic as well as actual volatility, respectively.

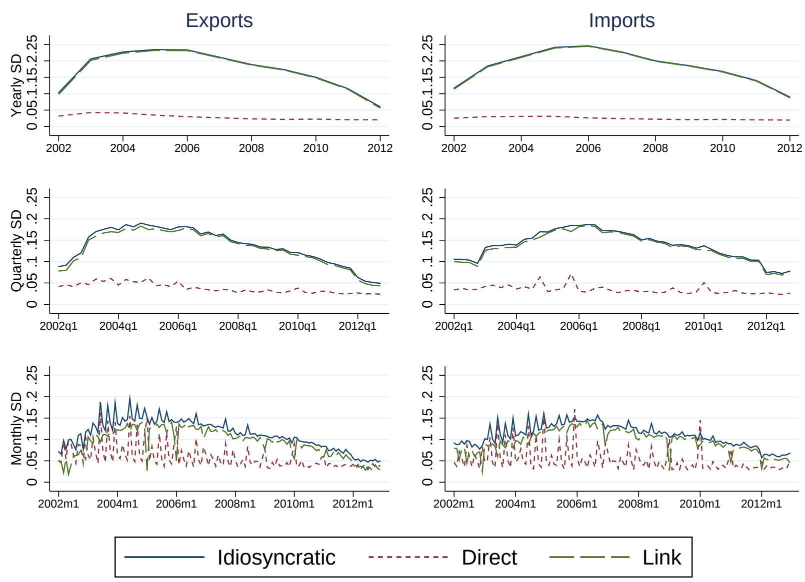
At yearly frequency, Table 2.6 shows that linkages between firms almost exclusively explain idiosyncratic volatility. Volatility due to comovement between firms amounts to 98 percent relative to total idiosyncratic volatility for both, exports and imports, and 84 and 88 percent relative to actual volatility for exports and imports, respectively. This is true for all years: the top panel of Figure 2.4 shows that the series of total idiosyncratic volatility and volatility due to firm-to-firm linkages, *Link*, are virtually identical. In contrast, at yearly frequency, the

Table 2.6: Contribution to Idiosyncratic Volatility: Firm-Specific Shocks and Network Effects

| | monthly | | | quarterly | | | yearly | | |
|---|---|---|---|---|---|---|---|---|---|
| | SD | Rel. SD (Idiosyncratic) | Rel. SD (Actual) | SD | Rel. SD (Idiosyncratic) | Rel. SD (Actual) | SD | Rel. SD (Idiosyncratic) | Rel. SD (Actual) |
| *services exports* | | | | | | | | | |
| Idiosyncratic | 0.1128 | 1.0000 | 0.8059 | 0.1366 | 1.0000 | 0.8489 | 0.1730 | 1.0000 | 0.8569 |
| Direct | 0.0586 | 0.5297 | 0.4276 | 0.0379 | 0.2933 | 0.2488 | 0.0287 | 0.1839 | 0.1559 |
| Link | 0.0923 | 0.8129 | 0.6537 | 0.1308 | 0.9516 | 0.8080 | 0.1703 | 0.9801 | 0.8404 |
| *services imports* | | | | | | | | | |
| Idiosyncratic | 0.1107 | 1.0000 | 0.8681 | 0.1378 | 1.0000 | 0.8902 | 0.1828 | 1.0000 | 0.8936 |
| Direct | 0.0524 | 0.4731 | 0.4110 | 0.0341 | 0.2562 | 0.2285 | 0.0248 | 0.1443 | 0.1296 |
| Link | 0.0949 | 0.8621 | 0.7484 | 0.1331 | 0.9640 | 0.8580 | 0.1810 | 0.9888 | 0.8834 |

*Notes*: This table shows the contribution of volatilities of shocks to individual trade relationships (Direct) and the contribution of covariances between firms (Link) for total firm-specific idiosyncratic volatility, $\sigma_{\varepsilon\tau}$, for monthly, quarterly and yearly frequencies according to the decomposition in equation (2.4). The first column of each block of frequencies presents averages of the standard deviations over the sample. The second column presents averages of standard deviations relative to total firm-specific volatility. The third column presents averages of standard deviations relative to actual volatility. Results for exports and imports are given in the top and bottom panel, respectively.

Figure 2.4: Contribution of Idiosyncratic Shocks and Network Effects




*Notes:* This figure shows the contribution of volatilities of shocks to individual trade relationships (Direct) and the contribution of covariances between firms (Link) for total firm-specific idiosyncratic volatility, $\sigma_{\varepsilon T}$, based on the decomposition in equation (2.4). The top, middle and bottom panel show the yearly series, quarterly and monthly series, respectively. Series for services exports and imports are given in the left and right panel, respectively.

volatility of the *Direct* component shows a relatively stable pattern over time. Relative to the actual standard deviation, the volatility of idiosyncratic shocks, though non-negligible, is smaller and amounts to 16 and 13 percent for exports and imports, respectively. The finding that network linkages between firms explain most of total idiosyncratic volatility is again robust with respect to firms' sales in France as shown by di Giovanni et al. (2014).

However, this picture significantly changes when looking at monthly frequency. While linkages between firms still are the dominant driving force, the standard deviation of the *Direct* component relative to actual volatility amounts to more than 40 percent for exports and imports, respectively. The bottom panel of Figure 2.4 shows the evolution of each component for monthly frequency. The series of the *Direct* component is highly volatile and characterized by large spikes over the whole sample. Hence, shocks to individual trade relationships alone have a considerable impact in the short run. At yearly frequency, the impact of the *Link* component becomes larger as the number of active firms and the number of trade relationships increases, giving rise to potential inter-firm linkages through which shocks to individual trade relationships propagate which in turn leads to comovement across firms. This provides empirical support that both arguments for the *Direct* and *Link* component to matter for aggregate fluctuations, are not different channels, but instead, mutually intertwined driving forces, as recently argued by Gabaix (2016).

### 2.4.4 Diversification of Idiosyncratic Shocks Within Firms

Given that Section 2.3 showed that there are not only differences in the decomposition of trade portfolios in terms of trading partners and services across firms, but also a high concentration on transaction with core trade relationships within firms, we now analyse how overall volatility is affected when taking the diversification within firms into account. To this end, we consolidate shocks stemming from individual trade relationships within firms, *i.e.* we shut down the extensive margin within firms as an additional source of variation. While our focus so far was on the contribution of idiosyncratic shocks to individual firms' trade relationships, we now analyse how shocks to individual firms' overall trade affect aggregate fluctuations by taking the allocation of individual firms' trade portfolios seriously.

In order to asses the impact of firms' diversification, we decompose weights of firms' individual trade relationships, $w_{fcst}$, into a between- and a within-firm component as

$$\begin{aligned} w_{fcst} &= \frac{x_{fcst} + x_{fcst-1}}{x_t + x_{t-1}} = \frac{x_{ft} + x_{ft-1}}{x_t + x_{t-1}} \times \frac{x_{fcst} + x_{fcst-1}}{x_{ft} + x_{ft-1}} \\ &= w_{ft}^{between}\ w_{fsct}^{within}, \end{aligned}$$

which allows a consolidation of growth rates of trade relationships within a firm. The consolidated actual variance of firm growth with between-firm weights being fixed at their time $\tau$ value can then be written as:

$$\sigma^2_{\gamma'\tau} = \text{Var}\left(\sum_{fsc} w_{f\tau}^{between}\ w_{fsct}^{within} \gamma_{fsct}\right) = \text{Var}\left(\sum_{f} w_{f\tau}^{between} \gamma_{ft}\right) . \tag{2.5}$$

Analogously, the variance of idiosyncratic shocks to firms' sales or purchases with between-firm weights being fixed at their time $\tau$ value is given by

$$\sigma^2_{\xi\tau} = \text{Var}\left(\sum_{fsc} w_{f\tau}^{between}\ w_{fsct}^{within} \varepsilon_{fsct}\right) = \text{Var}\left(\sum_{f} w_{f\tau}^{between} \xi_{ft}\right) , \tag{2.6}$$

where $\xi_{ft}$ represents shocks to individual firms' overall exports or imports. Hence, this measure diversifies shocks stemming from firms' individual trade relationships.[12]

[12] This measure is more in line with empirical studies which focus on the role of idiosyncratic shocks to firms' overall sales rather than individual trade flows, as *e.g.* Gabaix (2011).

Table 2.7 presents the results of this decomposition for monthly, quarterly and yearly frequencies. The first column of each block of frequencies presents averages of the diversified actual volatility, the volatility of shocks at the macro-meso-level, and the diversified idiosyncratic volatility, respectively.[13] The second column presents averages of standard deviations relative to the diversified actual volatility. Results for exports and imports are given in the top and bottom panel, respectively.

Table 2.7: Contribution to Service Trade Volatility: Macro-Meso and Diversified Idiosyncratic Shocks

| | monthly | | quarterly | | yearly | |
|---|---|---|---|---|---|---|
| | SD | Rel. SD | SD | Rel. SD | SD | Rel. SD |
| *Service Exports* | | | | | | |
| Diversified Actual | 0.1213 | 1.0000 | 0.1155 | 1.0000 | 0.1230 | 1.0000 |
| Macro-Meso | 0.0919 | 0.7906 | 0.0828 | 0.7596 | 0.0812 | 0.7330 |
| Diversified Idiosyncratic | 0.0947 | 0.7684 | 0.0967 | 0.8251 | 0.1087 | 0.8701 |
| *Service Imports* | | | | | | |
| Diversified Actual | 0.1044 | 1.0000 | 0.1032 | 1.0000 | 0.1139 | 1.0000 |
| Macro-Meso | 0.0912 | 0.8988 | 0.0838 | 0.8559 | 0.0863 | 0.8363 |
| Diversified Idiosyncratic | 0.0862 | 0.8317 | 0.0884 | 0.8686 | 0.0972 | 0.8657 |

*Notes*: This table shows the contribution of macro-meso and diversified idiosyncratic shocks, as given by equation (2.6), to diversified actual services trade volatility, as given by equation (2.5), for monthly, quarterly and yearly frequencies. The first column of each block of frequencies presents averages of the standard deviations over the sample (*i.e.* $1/T \sum \sigma_{n\tau}$ for $n \in \{\gamma', \delta, \xi\}$). The second column presents averages of standard deviations relative to aggregate (diversified) volatility (*i.e.* $1/T \sum \sigma_{n\tau}/\sigma_{\gamma'\tau}$ for $n \in \{\gamma', \delta, \xi\}$). Results for exports and imports are given in the top and bottom panel, respectively.

Table 2.7 shows that firms' individual diversification reduces actual volatility at all frequencies. At yearly frequency diversified actual volatility of exports and imports is 38 and 44 percent lower compared to undiversified actual volatility, see Table 2.4. In addition, the consolidation of shocks stemming from individual trade relationships reduces firm-specific export and import volatility by 37 and 46 percent, respectively, while the relative contribution is by and large the same.[14]

As seen in Section 2.4.1, the undiversified idiosyncratic volatility increases at lower frequency

[13] The variance of shocks at the macro-meso-level is not affected by the diversification within firms.

[14] This is consistent with recent findings by Kramarz et al. (2015). Using yearly data on French firms' trade networks and a different decomposition metric, the authors show that while controlling for the impact of macro-level shocks and shocks specific to individual firms, shocks to seller-buyer relationships are quantitatively important for overall volatility.

since firms' transactions are lumpy and they trade only very infrequently in the course of a year. Table 2.7 shows that the increase in diversified idiosyncratic volatility from monthly to yearly frequency is only very modest. Hence, the consolidation of shocks among trading partners diversifies the lumpiness of transactions to a large extent. These findings suggest, that when it comes to an assessment of the impact of the openness to trade on overall volatility, it is crucial to be aware of the level of (dis)aggregation, both, along the time as well as along firm-level dimension.

We also decompose diversified firm-specific shocks into shocks to individual firms alone, the *Direct* component, and the volatility due to comovement between firms, the *Link* component, see Table A.2.3. Since the diversified volatility measure consolidates shocks stemming from firms' individual trade relationships, giving less rise to trade linkages and leaving as only source of comovement links between firms' total sales, we find the *Link* component to be slightly less important compared to our results in Table 2.6. In contrast, we would expect the *Direct* component to increase in importance as weights attached to firms' total sales are higher than for individual trade relationships giving a more prominent role to larger firms. Though comovement still is relatively more important in explaining actual service trade volatility, we indeed find that the contribution of the *Direct* component more than doubles at yearly frequency. In addition, shocks to individual firms alone are even as important as linkages between firms for exports with a standard deviation relative to actual diversified volatility of nearly 70 percent at monthly frequency. This confirms our finding from the previous sub-section that both channels are actually two sides of the same coin that are mutually important for aggregate fluctuations.

## 2.5 Conclusion

In this paper, we analyse how firm-level activities shape aggregate services trade volatility. We find that idiosyncratic shocks stemming from firms' trade relationships are most important for explaining overall services trade volatility with a relative contribution of more than 80 percent. In addition, idiosyncratic volatility is increasing from monthly to yearly frequency reflecting the lumpiness of firms transactions and firms' imperfect intertemporal diversification. We find that comovement between firms explains most of idiosyncratic fluctuations at all frequencies. However, their impact decreases at monthly frequency while the impact of shocks to firms' trade relationships alone becomes larger, suggesting that both components are mutually important for explaining idiosyncratic volatility. Finally, when consolidating shocks to individual trade relationships within firms, we find aggregate services trade and firm-specific idiosyncratic volatility to be roughly 40 percent smaller. Given that the absolute and relative contribution of idiosyncratic volatility is by and large the same across frequencies, this also implies that the consolidation of shocks within firms also diversifies the lumpiness of firms' transactions.

# Appendix to Chapter 2

Table A.2.1: Heterogeneity Within Firms, Transactions, Monthly Averages for 2001-2012

| | Rank of transaction | | | | | | | Trade | Within-firm | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 10 | 25 | volume | $HI$ | $HI^{norm}$ |
| *Percent of exports* | | | | | | | | | | |
| Exact 2 transactions | 74.61 | 25.39 | – | – | – | – | – | 1,099 | 0.67 | 0.33 |
| Exact 3 transactions | 64.84 | 24.18 | 10.98 | – | – | – | – | 1,711 | 0.54 | 0.31 |
| Exact 4 transactions | 58.87 | 23.25 | 11.74 | 6.14 | – | – | – | 2,068 | 0.47 | 0.29 |
| Exact 5 transactions | 55.49 | 22.24 | 11.67 | 6.74 | 3.86 | – | – | 2,804 | 0.43 | 0.28 |
| Exact 10 transactions | 44.41 | 19.81 | 11.64 | 7.59 | 5.30 | 1.06 | – | 4,437 | 0.31 | 0.23 |
| Exact 25 transactions | 33.36 | 15.85 | 10.39 | 7.46 | 5.72 | 2.19 | 0.17 | 21,207 | 0.20 | 0.16 |
| *Percent of imports* | | | | | | | | | | |
| Exact 2 transactions | 72.29 | 27.71 | – | – | – | – | – | 650 | 0.64 | 0.28 |
| Exact 3 transactions | 62.36 | 25.06 | 12.58 | – | – | – | – | 667 | 0.51 | 0.27 |
| Exact 4 transactions | 56.69 | 23.55 | 12.57 | 7.18 | – | – | – | 701 | 0.44 | 0.26 |
| Exact 5 transactions | 53.12 | 22.40 | 12.41 | 7.49 | 4.58 | – | – | 987 | 0.40 | 0.25 |
| Exact 10 transactions | 43.00 | 19.66 | 11.84 | 7.91 | 5.60 | 1.14 | – | 1,818 | 0.29 | 0.21 |
| Exact 25 transactions | 32.49 | 16.01 | 10.51 | 7.63 | 5.84 | 2.13 | 0.17 | 8,433 | 0.19 | 0.16 |

*Notes*: This table shows the average shares (in percent) of exports and imports for those transactions ranked first, second, third, etc. and firms that engage exactly two, three, four, etc. times in service-country trade in a given year. Average trade volumes are rounded and reported in thousand Euro. $HI$ and $HI^{norm}$ denote the usual and normalised within-firm Herfindahl index, respectively (see footnote 2).

Table A.2.2

| | monthly | | | quarterly | | | yearly | | |
|---|---|---|---|---|---|---|---|---|---|
| | SD | Rel. SD (Firm) | Rel. SD (Actual) | SD | Rel. SD (Firm) | Rel. SD (Actual) | SD | Rel. SD (Firm) | Rel. SD (Actual) |
| *Service Exports* | | | | | | | | | |
| Idiosyncratic | 0.1128 | 1.0000 | 0.8059 | 0.1366 | 1.0000 | 0.8489 | 0.1730 | 1.0000 | 0.8569 |
| Extensive Margin | 0.0198 | 0.1780 | 0.1447 | 0.0150 | 0.1127 | 0.0960 | 0.0107 | 0.0661 | 0.0559 |
| Intensive Margin | 0.0479 | 0.4363 | 0.3503 | 0.0638 | 0.4725 | 0.4018 | 0.0927 | 0.5351 | 0.4607 |
| *Service Imports* | | | | | | | | | |
| Idiosyncratic | 0.1107 | 1.0000 | 0.8681 | 0.1378 | 1.0000 | 0.8902 | 0.1828 | 1.0000 | 0.8936 |
| Extensive Margin | 0.0187 | 0.1708 | 0.1492 | 0.0161 | 0.1164 | 0.1035 | 0.0124 | 0.0668 | 0.0594 |
| Intensive Margin | 0.0469 | 0.4319 | 0.3753 | 0.0628 | 0.4645 | 0.4149 | 0.0966 | 0.5345 | 0.4793 |

*Notes*: This table shows idiosyncratic volatility for the full sample, as well as for sub-samples of growth rates belonging to extensive and intensive margin, respectively, for monthly, quarterly and yearly frequencies. The first column of each block of frequencies presents averages of the standard deviations over the sample. The second column presents averages of standard deviations relative to firm-specific idiosyncratic volatility. The third column presents averages of standard deviations relative to actual volatility. Results for exports and imports are given in the top and bottom panel, respectively.

Table A.2.3: Contribution to Diversified Idiosyncratic Volatility: Firm-Specific Shocks and Network Effects

| | monthly | | | quarterly | | | yearly | | |
|---|---|---|---|---|---|---|---|---|---|
| | SD | Rel. SD (Idiosyncratic) | Rel. SD (Actual) | SD | Rel. SD (Idiosyncratic) | Rel. SD (Actual) | SD | Rel. SD (Idiosyncratic) | Rel. SD (Actual) |
| *Service Exports* | | | | | | | | | |
| Diversified Idiosyncratic | 0.0947 | 1.0000 | 0.7684 | 0.0967 | 1.0000 | 0.8251 | 0.1087 | 1.0000 | 0.8701 |
| Direct | 0.0622 | 0.6831 | 0.5180 | 0.0447 | 0.5068 | 0.4081 | 0.0374 | 0.3971 | 0.3336 |
| Link | 0.0693 | 0.6940 | 0.5427 | 0.0842 | 0.8358 | 0.6979 | 0.1008 | 0.8948 | 0.7866 |
| *Service Imports* | | | | | | | | | |
| Diversified Idiosyncratic | 0.0862 | 1.0000 | 0.8317 | 0.0884 | 1.0000 | 0.8686 | 0.0972 | 1.0000 | 0.8657 |
| Direct | 0.0513 | 0.5949 | 0.4935 | 0.0402 | 0.4692 | 0.4078 | 0.0341 | 0.3794 | 0.3316 |
| Link | 0.0674 | 0.7848 | 0.6540 | 0.0782 | 0.8770 | 0.7616 | 0.0905 | 0.9180 | 0.7929 |

*Notes*: This table shows the contribution of volatilities of shocks to individual trade relationships (Direct) and the contribution of covariances between firms (Link) for diversified idiosyncratic volatility, $\sigma_{\xi_T}$, for monthly, quarterly and yearly frequencies. The first column of each block of frequencies presents averages of the standard deviations over the sample. The second column presents averages of standard deviations relative to diversified firm-specific volatility. The third column presents averages of standard deviations relative to actual diversified volatility. Results for exports and imports are given in the top and bottom panel, respectively.

# Chapter 3

# A Structural Quantitative Analysis of Services Trade De-liberalization*

## 3.1 Introduction

While services transactions account for the lion's share of economic activity in developed economies, and such transactions often cross national borders, many quantitative open-economy models portray countries to produce manufacturing goods only (see, e.g., Anderson and van Wincoop, 2003, Costinot et al., 2012), or services to be non-tradable (see, e.g., Eaton and Kortum, 2002). One consequence of this practice is that we know much less about key parameters governing quantitative responses of the services sector than about those of manufacturing. For example, there is a wealth of results on the so-called trade elasticity (with all its different theory-dependent interpretations) for goods (see Broda and Weinstein, 2006, Kee et al., 2008, 2009) and, more recently, on the shape parameter of the productivity distribution of manufacturers (see Eaton et al., 2011). Similar results are much scarcer for services as high-quality data on services-producing firms and their trade have become available only recently (e.g., Breinlich and Criscuolo, 2011, as well as Ariu, 2016a, provide evidence for the United Kingdom and Belgium, respectively; Caliendo and Parro, 2015, is one of the few quantitative multi-sector-multi-country analyses covering goods as well as services sectors).

The present paper analyzes census-type data on services producers and traders in Germany, which is one of the most important open economies on the globe. We contribute to the literature by informing a quantifiable multi-sector-multi-country model of goods and services production and consumption, which allows the calibration of overall (variable and fixed) costs to

*This chapter is joint work with Peter H. Egger (ETH Zürich), Valeria Merlo (University of Tübingen) and Georg Wamser (University of Tübingen). The disclaimer above applies.

market-specific sales in a sector and decomposing these costs into observable and unobservable components. The model features sector-specific markups, market-penetration and productivity-distribution parameters, as well as overall (variable and fixed) transaction costs. The latter parameter varies by sector and exporter-importer country pair.

All of the fundamental parameters are estimated and calibrated on the basis of three datasets: one pertaining to transaction-level data of services exports of firms in Germany; one pertaining to overall sales of manufactures and services of firms in Germany; and one pertaining to input-output relationships for multiple countries and sectors.

The transaction-level data suggest that the (export) sales distribution of services is not Pareto, and that matching the data requires allowing for sector-destination-country-specific shape parameters of a single-parameter Pareto distribution as well as of an imperfect penetration of the sector and country across exporters. The corresponding parametrization is able to capture the distribution of sales across sectors quite well. Moreover, the data suggest that the variance of (normalized) overall transaction costs differs substantially across the considered service-sector aggregates, being largest for Construction Services. Across all considered sectors, the role of geographical distance is for overall transaction costs relatively minor, while preferential services-market access through trade agreements reduces transaction costs substantially. Hence, the (inverse-)distance equivalent to preferential services-market access is large.

We proceed by using the partial effects of preferential market access on services transaction costs to study the exit – or de-liberalization – from preferential services trade agreements by individual countries and, alternatively, all covered countries jointly. The corresponding findings suggest that abandoning preferential market access bilaterally and reciprocally for a large and remote economy (with relatively little preferential market access ex ante) such as the United States leads to a relatively small reduction of real consumption below 0.1 percent with effects on real wages and dividends of a similar magnitude. The effect amounts to about 0.3 percent for a somewhat smaller and less remote country (that operates under relatively wider preferential market access ex ante) such as the United Kingdom. And the effect amounts to about 0.9 percent for a small, central, open economy such as Belgium. When de-liberalizing preferential services-market access on a world-wide basis as of 2014, the model suggests that real consumption will drop across countries in the range of 0.1 percent to 12.5 percent (depending on the country). The effects on real wages and dividends are quantified at a similar magnitude, and negative effects are found even for manufactures, on average, although we kept preferential market access and the other policy environment unchanged for the latter sector.

The remainder of the paper is organized as follows. The subsequent section introduces our data. Section 3.3 outlines the key elements of our firm-level model. Section 3.4 presents the estimation of the fundamental model parameters. Section 3.5 presents the multi-country-multi-sector general equilibrium. Section 3.6 outlines the effects of a partial removal of deep preferential market access in multi-country-multi-sector general equilibrium. The last section concludes with a brief summary of our findings.

## 3.2 Data

In order to conduct our analysis we use transaction-level, firm-level as well as country-sector-level information that comes from various sources.

First, we use the International Trade in Services Statistics (SITS) compiled by the Deutsche Bundesbank and provided by its Research Data and Service Centre (RDSC). A detailed description of this dataset can be found in Biewen and Lohner (2017). The data entails detailed information on German firms' services exports at the transaction-level, i.e. the period of the occurrence of transactions, the destination country and the type of service traded. Service transactions with an overall outgoing value exceeding 12,500 Euro per month needs to be reported.[1] The data covers all modes of services transactions of the General Agreement on Trade in Services (GATS), i.e. cross-border trade (mode 1), consumption abroad (mode 2), and the presence of natural persons in the country of the customer (mode 4) with the only exception being services transactions of foreign affiliates in the country of the customer (mode 3). From 2014 onwards individual transactions have to be reported according to the sixth version of the IMF's Balance of Payments and the International Investment Position Manual (BPM6) that contains a more detailed breakdown of services transactions compared to the BPM5. For the sake of our econometric analyses, however, we group individual transactions into one of five broad service categories: Transport Services, Construction Services, Information and Communication (ICT) Services, Other Business Services and Other Services.[2] In addition, we drop sector-country combinations with fewer than 50 observations. We restrict our sample to 28 EU countries and 15 other major countries plus the rest of the world for 2014.

Second, given that this transaction-level data does neither cover bilateral trade in manufactures nor German services sales at home, we refrain to German non-financial firms' financial statements (Ustan) as a bypass, which is also prepared by Deutsche Bundesbank, see Stöß (2001)

[1]Hence, the volume traded that we observe in the data may actually comprise several transactions within a given period of time. We stick to this slight abuse of terminology in order to distinguish this data conceptually from the firm-level data we use.

[2]We broadly follow the IMF's BPM6 Compilation Guide (2014), Chapter 12, see http://www.imf.org/external/pubs/ft/bop/2014/pdf/Guide.pdf (accessed December 2017). See the Appendix for further details.

for a description. This dataset covers firms' overall sales and exports.[3] This allows us to gather information on exports to the rest of the world of German manufacturers as well as domestic sales of firms belonging to the manufacturing and the five services sectors.[4]

Third, in order to extract information on our measure for barriers in international services trade, its decomposition and to calibrate our model for the counterfactual analysis we use sector-country information from the World Input-Output Database Release 2016 (WIOD), see Timmer et al. (2015) and Timmer et al. (2016) as well as the CEPII database, see Head et al. (2010).

## 3.3 Theoretical Framework

Using firm-level data for Germany, we will demonstrate in the subsequent section that producers of services in the aforementioned five sectors and producers in manufacturing make operating profits, are heterogeneous as in Melitz (2003), do not serve all markets as in Helpman et al. (2008), but the distribution of their sales deviates from a single-parameter Pareto distribution. The literature proposes two alternative treatments for this problem, one of which is to part with the Pareto assumption about firm productivity (see, e.g., Bas et al., 2015), the other one is to superimpose an assumption about the imperfect penetration of consumer markets by the sellers (see Arkolakis, 2010, Eaton et al., 2011). We follow the latter approach in what follows.

For the subsequent outline of the model, it will be useful to use indices $v$, $s$, $i$, and $j$ to denote firms, sectors, producer countries, and consumer countries, respectively. We use $S$ and $J$ to denote the total number of sectors and countries in the world economy, respectively.

### 3.3.1 Firm-Level Trade

Following Arkolakis (2010), we assume that firm $v$ in country $i$ – offering one differentiated variety $v$ of sector-$s$ output under monopolistic competition – must incur costs to penetrate market $j$, with market penetration costs being paid in $si$-specific factor costs per efficiency unit, $c_i^s$,

$$f_{ij}^s(v) = c_i^s f_{ij}^s \frac{1 - \left[1 - n_{ij}^s(v)\right]^{1-1/\lambda_j^s}}{1 - 1/\lambda_j^s}, \tag{3.1}$$

where $f_{ij}^s > 0$ is a common fixed cost for all producers in sector $s$ and country $i$ who target consumers in country $j$ and the second term on the right-hand side of equation (3.1) are firm-

[3]Note that the information on exports is provided by firms on a voluntary basis. Hence, in some cases a zero may indicate no export activity or no information provided.

[4]As the focus of the paper is on services, we do not distinguish among manufacturing sectors but treat the latter as one block.

specific market penetration costs of the same producers to customers in country $j$. Market penetration costs are increasing in the fraction of buyers reached, $n_{ij}^s(v) \in [0,1]$, where the degree of reach is governed by the shape parameter of the penetration cost function, $\lambda_j^s > 0$. An increase in $\lambda_j^s$ makes it easier to penetrate a market, resulting in higher overall entry costs. As $\lambda_j^s \to \infty$, $n_{ij}^s(v) \to 1$ so that the market penetration cost specification in equation (3.1) degenerates to the fixed cost specification as in Melitz (2003) or Helpman et al. (2008).

Buyers combine a continuum of varieties of sector-$s$ output with a constant-elasticity-of-substitution (CES) aggregator with elasticity $\sigma^s > 1$. Sales of firm $v$ offering sector-$s$ output in market $j$ and reaching a fraction $n_{ij}^s(v)$ of buyers are then given by

$$x_{ij}^s(v) = n_{ij}^s(v) \left( \frac{p_{ij}^s(v)}{P_j^s} \right)^{1-\sigma_s} E_j^s \,,$$

where $p_{ij}^s(v)$ is the price in country $j$ for variety $v$ which belongs in sector $s$ and originates from country $i$. $P_j^s$ denotes the sectoral price index of sector-$s$ output in country $j$, and $E_j^s$ are aggregate expenditures on sector-$s$ output in country $j$. Total profits of firm $v$ from providing service $s$ in country $j$ are given by its operating profits, *i.e.* sales net of input costs, minus market penetration costs

$$\pi_{ij}^s(v) = \frac{1}{\sigma^s} n_{ij}^s(v) \left( \frac{p_{ij}^s(v)}{P_{ij}^s} \right)^{1-\sigma^s} E_{ij}^s - c_i^s f_{ij}^s \frac{1 - \left[1 - n_{ij}^s(v)\right]^{1-1/\lambda_j^s}}{1 - 1/\lambda_j^s} \,.$$

Under monopolistic competition, $p_{ij}^s(v)$ involves a fixed mark up over marginal costs of the form

$$p_{ij}^s(v) = \frac{\sigma^s}{\sigma^s - 1} \frac{\tau_{ij}^s c_i^s}{\phi(v)} \,,$$

where $\tau_{ij}^s \geq 1$ are the common ad-valorem (iceberg) trade costs for sector $s$ and shipments from country $i$ to country $j$, and $\phi(v)$ is the efficiency of firm $v$. The degree of market penetration is optimal if an $i$-borne firm's operating profits in sector $s$ and market $j$ for a buyer will just cover the marginal costs of reaching that buyer:

$$\frac{1}{\sigma^s} \left[ \frac{\frac{\sigma^s}{\sigma^s-1} \frac{\tau_{ij}^s c_i^s}{\phi(v)}}{P_j^s} \right]^{1-\sigma^s} E_j^s = \frac{c_i^s f_{ij}^s}{\left[1 - n_{ij}^s(v)\right]^{1/\lambda_j^s}} \,. \tag{3.2}$$

The marginal firm – indicated by $*$ – in sector $s$ and country $i$ will just not serve any customer in market $j$ so that $n_{ij}^s(v^*) = 0$. Using equation (3.2), the cutoff-efficiency level can be expressed as

$$\left(\phi_{ij}^{s*}\right)^{\sigma^s-1} = \sigma^s c_i^s f_{ij}^s \left[ \left( \frac{\frac{\sigma^s}{\sigma^s-1} \tau_{ij}^s c_i^s}{P_j^s} \right)^{1-\sigma^s} E_j^s \right]^{-1} \,. \tag{3.3}$$

Inserting the expression for $\left(\phi_{ij}^{s*}\right)^{\sigma^s-1}$ into equation (3.2) yields the firm-specific optimal degree of market penetration as a function of firm $v$'s efficiency, $\phi(v)$:

$$n_{ij}^s(v) = 1 - \left[\frac{\phi_{ij}^{s*}}{\phi(v)}\right]^{(\sigma^s-1)\lambda_j^s} .$$

For a given efficiency level $\phi(v) > \phi_{ij}^{s*}$, $n_{ij}^s(v)$ is increasing in the degree of competition, $\sigma^s$, as firms try to compensate for a decline in sales per buyer by reaching more buyers.

Using these insights, the value of sales of an $i$-borne firm $v$ in sector $s$ to buyers in destination $j$ can then be expressed as

$$\begin{aligned} x_{ij}^s(v) &= \sigma^s c_i^s f_{ij}^s \left[\frac{\phi(v)}{\phi_{ij}^{*s}}\right]^{\sigma^s-1} \left\{1 - \left[\frac{\phi_{ij}^{s*}}{\phi(v)}\right]^{(\sigma^s-1)\lambda_j^s}\right\} \\ &= \tilde{x}_{ij}^s(v) n_{ij}^s(v) , \end{aligned} \tag{3.4}$$

where $\tilde{x}_{ij}^s(v)$ are firm $v$'s sales of service $s$ in market $j$ per fraction of customers reached.

### 3.3.2 Producer Heterogeneity and Average Sales

Let us assume that there is a constant mass of firms in country $i$, $\mathcal{M}_i$, which draw their efficiency level from a Pareto distribution with support $[b_i^s, +\infty)$. Rather than assuming that the shape of the distribution is independent of the country where output is sold, as, e.g., in Eaton and Kortum (2002) or Melitz (2003), we allow this shape to be specific for a sector and country of destination of sales. Implicitly, this means that a fixed number of firms in a country of origin, $\mathcal{M}_i$, is quasi endowed with a *minimum efficiency* $b_i^s$, and gets a free draw of *actual efficiency* for any destination country $j$ from the aforementioned support with a shape parameter $k_j^s > \sigma^s - 1$, but still has to invest in market-access costs $f_{ij}^s(v)$ when willing to serve that market after all.

The probability that a firm $v$ with productivity $\phi(v)$ is active in providing a service $s$ out of country $i$ to market $j$ is given by $1 - \Pr\left[\phi(v) < \phi_{ij}^{s*}\right] = \left(\frac{b_i^s}{\phi_{ij}^{s*}}\right)^{k_j^s}$. The measure of firms selling sector-$s$ output to country $j$ is then given by

$$M_{ij}^s = \mathcal{M}_i \left(\frac{b_i^s}{\phi_{ij}^{s*}}\right)^{k_j^s} . \tag{3.5}$$

Integrating bounded-Pareto-distributed firms' sales, equation (3.4) gives average sales per selling firm of

$$\bar{x}_{ij}^s = \int_{\phi_{ij}^{s*}}^{\infty} x_{ij}^s(v) k_j^s \left(\phi_{ij}^{s*}\right)^{k_j^s} (\phi)^{(-1-k_j^s)} \; d\phi = \sigma^s c_i^s f_{ij}^s \Theta_j^s , \tag{3.6}$$

with $\Theta_j^s = \frac{\theta_j^s \lambda_j^s}{(1-\theta_j^s)\left[1-\theta_j^s(1-\lambda_j)\right]}$ and $\theta_j^s = \frac{\sigma^s - 1}{k_j^s}$.[5] Average sales of firms whose efficiency is higher than $\phi(v)$ are given by:

$$\bar{x}_{ij}^s(v) = \sigma^s c_i^s f_{ij}^s \left(\frac{\phi_{ij}^{s*}}{\phi(v)}\right)^{-(\sigma^s-1)} \left[\frac{1}{1-\theta_j^s} - \frac{1}{1-\theta_{ij}^s(1-\lambda_{ij}^s)}\left(\frac{\phi_{ij}^{s*}}{\phi(v)}\right)^{(\sigma^s-1)\lambda_j}\right]. \tag{3.7}$$

For later use let us also define the ratio of equation (3.7) and equation (3.6)

$$\frac{\bar{x}_{ij}^s(v)}{\bar{x}_{ij}^s} = \left(\frac{\phi_{ij}^{s*}}{\phi(v)}\right)^{-(\sigma^s-1)} \left\{\frac{1-\theta_j^s}{\theta_j^s \lambda_j}\left[1-\left(\frac{\phi_{ij}^{s*}}{\phi(v)}\right)^{(\sigma^s-1)\lambda_j}\right]+1\right\}. \tag{3.8}$$

By the same token, average sales of firm $v$ per fraction of buyers reached,

$$\tilde{x}_{ij}^s(v) = \sigma^s c_i^s f_{ij}^s \left(\frac{\phi_{ij}^{s*}}{\phi(v)}\right)^{-(\sigma^s-1)},$$

can be written as

$$\bar{\tilde{x}}_{ij}^s = \frac{\sigma^s c_i^s f_{ij}^s}{1-\theta_{ij}^s}.$$

The average of $\tilde{x}_{ij}^s(v)$ for firms whose efficiency is greater than $\phi(v)$ is then given by

$$\bar{\tilde{x}}_{ij}^s(v) = \frac{\sigma^s c_i^s f_{ij}^s}{1-\theta_j^s}\left(\frac{\phi_{ij}^{s*}}{\phi(v)}\right)^{-(\sigma^s-1)}. \tag{3.9}$$

### 3.3.3 Aggregate Sales, Market Shares and Profits

Aggregate sales of all $i$-borne firms in sector $s$ to market $j$ are then given by

$$X_{ij}^s = M_{ij}^s \bar{x}_{ij}^s = M_{ij}^s \sigma^s c_i^s f_{ij}^s \Theta_j^s. \tag{3.10}$$

Average total profits, $\bar{\pi}_{ij}^s$, are a constant multiple of average sales:

$$\bar{\pi}_{ij}^s = c_i^s f_{ij}^s \Theta_j^s \theta_j^s = \frac{\theta_j^s}{\sigma^s}\bar{x}_{ij}^s. \tag{3.11}$$

and aggregate sectoral profits are $\Pi_i^s = \sum_{j=1}^J \Pi_{ij}^s = \sum_{j=1}^J M_{ij}^s \bar{\pi}_{ij}^s$. The market share of country $i$ exporting varieties of sector $s$ to country $j$ can be written as

$$\mu_{ij}^s = \frac{X_{ij}^s}{E_j^s} = \frac{X_{ij}^s}{\sum_{l=1}^J X_{lj}^s}.$$

[5] This formulation has the advantage that $\theta_j^s \in (0,1)$.

Following Arkolakis (2010), we can use equations (3.3), (3.5), and (3.10), and write the market share as

$$\mu_{ij}^s = \frac{M_{ij}^s \sigma^s c_i^s f_{ij}^s \Theta_j^s}{\sum_{l=1}^J M_{lj}^s \sigma^s c_l^s f_{lj}^s \Theta_j^s} = \frac{\mathcal{M}_i \left(\frac{b_i^s}{\tau_{ij}^s}\right)^{k_j^s} \left(f_{ij}^s\right)^{1-\frac{1}{\theta_j^s}} \left(c_i^s\right)^{1-\frac{1}{\theta_j^s}-k_j^s}}{\sum_{l=1}^J \mathcal{M}_l \left(\frac{b_l^s}{\tau_{lj}^s}\right)^{k_j^s} \left(f_{lj}^s\right)^{1-\frac{1}{\theta_j^s}} \left(c_l^s\right)^{1-\frac{1}{\theta_j^s}-k_j^s}}.$$

It turns out that changes in the fixed component of market entry, $f_{ij}^s$, and variable trade costs, $\tau_{ij}^s$, affect aggregate outcomes in general equilibrium as $\zeta_{ij}^s \equiv \left(\tau_{ij}^s\right)^{-k_j^s} \left(f_{ij}^s\right)^{1-\frac{1}{\theta_j^s}}$. Hence, changes in variable iceberg-type trade costs are observationally equivalent to scaled changes in the fixed cost component of market access costs. Given the restriction $k_j^s > \sigma^s - 1$, an increase in $\tau_{ij}^s$ has a larger negative impact on $\zeta_{ij}^s$ than an increase in $f_{ij}^s$. The market share $\mu_{ij}^s$ can then be written as

$$\mu_{ij}^s = \frac{\mathcal{M}_i \left(b_i^s\right)^{k_j^s} \left(c_i^s\right)^{1-\frac{1}{\theta_j^s}-k_j^s} \zeta_{ij}^s}{\sum_{l=1}^J \mathcal{M}_l \left(b_l^s\right)^{k_j^s} \left(c_l^s\right)^{1-\frac{1}{\theta_j^s}-k_j^s} \zeta_{lj}^s}. \tag{3.12}$$

## 3.4 Measuring the Fundamental Model Parameters

Fundamental parameters of the model can be determined in sequential steps. These steps will pertain to measuring $\{\sigma^s\}$, $\{\theta_j^s, \lambda_j^s, k_j^s\}$, and $\{\zeta_{ij}^s\}$. We address each of these steps in the following.

### 3.4.1 Estimation of $\sigma^s$

As in any CES framework with monopolistic competition, firm $v$'s operating profits from selling sector-$s$ output in market $j$ are proportional to the respective sales, namely $x_{ij}^s(v)/\sigma^s$. Hence, we can determine the elasticity of substitution by using information on firms' balance-sheet data.[6] We measure $\sigma^s$ as the sum of firms' sales belonging to sector $s$ over all destination markets divided by the sum of their corresponding operating profits. The results are summarized in Table 3.1. We find the highest values of $\widehat{\sigma}^s$ for Other Sectors (7.65) and Construction Services (6.00), suggesting high competition in these sectors. The lowest value (i.e., high market power) is found for Other Services (3.27).

### 3.4.2 Estimation of $\theta_j^s$, $\lambda_j^s$ and $k_j^s$

Towards estimating the structural parameters $\theta_j^s$ and $\lambda_j^s$, note that, when distinguishing $M_{ij}^s$ quantiles in the distribution of sales of firms in country $i$ and sector $s$ to market $j$, the probability

[6]While we observe firms' sales in the data directly, we calculate firms' operating profits as revenues minus personnel costs, material costs, and expenses on purchased services. We do not use earnings before the deduction of interest and taxes as these also comprise expenses that are not reflected in the model.

Table 3.1: Estimates of $\sigma^s$ Using Firm-level Data

| Sector | $\widehat{\sigma}^s$ | |
|---|---|---|
| Transport | 5.164 | (0.418) |
| Construction Services | 5.997 | (0.280) |
| IT Services | 3.915 | (0.244) |
| Other Business Services | 4.512 | (0.219) |
| Other Services | 3.273 | (0.078) |
| Manufacturing | 4.855 | (0.036) |
| Other Sectors (n.c.e.) | 7.647 | (0.102) |

*Note*: Bootstrapped standard errors in parentheses.

that a firm has higher efficiency than $\phi(v)$ can be written as

$$1 - \Pr_{ij}^s(v) = \left(\frac{\phi_{ij}^{s*}}{\phi(v)}\right)^{k_j^s} = \frac{rank_{ij}^s(v)}{M_{ij}^s}, \tag{3.13}$$

where, after sorting firms according to their rank in terms of sales and letting $v$ denote this rank, $rank_{ij}^s(v) = 100(v-1)$. Since we focus on all firms rather than percentiles, $rank_{ij}^s(v)$ is quasi-continuous. Notice that a stochastic version of the log-transformed equation (3.8) is

$$\ln\left[\frac{\bar{x}_{ij}^s(v)}{\bar{x}_{ij}^s}\right] = -\theta_j^s \ln\left[1 - \Pr_{ij}^s(v)\right] + \ln\left[\frac{1-\theta_j^s}{\theta_j^s\lambda_j^s}\left\{1 - \left[1 - \Pr_{ij}^s(v)\right]^{(\theta_j^s\lambda_j^s)}\right\} + 1\right] + \varepsilon_{vij}^s \tag{3.14}$$

from which $\theta_j^s$ and $\lambda_j^s$ could be principally estimated using non-linear least squares. However, it turns out that this optimization problem is very flat, which makes it hard to estimate the global optimum of $\{\theta_j^s, \lambda_j^s\}$ for each country $j$ and sector $s$. We overcome this problem by additionally using an expression for $\bar{\tilde{x}}_{ij}^s(v)$, which can be calculated as the cumulative average of $\tilde{x}_{ij}(v) = x_{ij}^s/n_{ij}^s$. Doing so involves the fraction of customers reached, which, using equation (3.13), can be written as

$$n_{ij}^s(v) = 1 - \left[1 - \Pr_{ij}^s(v)\right]^{\theta_j^s\lambda_j^s}. \tag{3.15}$$

The latter and, hence, $\bar{\tilde{x}}_{ij}^s(v)$, depends on the yet unknown $\theta_j^s\lambda_j^s$. After using the insight of equation (3.15) in equation (3.9), a stochastic equation for $\ln\bar{\tilde{x}}_{ij}^s(v)$ can be written as

$$\ln\bar{\tilde{x}}_{ij}^s(v) = \ln\frac{\sigma^s c_s f_{ij}^s}{1-\theta_j^s} - \theta_j^s \ln\left[1 - \Pr_{ij}^s(v)\right] + \epsilon_{vij}^s. \tag{3.16}$$

In order to estimate $\theta_j^s$ and $\lambda_j^s$ based on equations (3.14) and (3.16), we apply an iterative procedure based on the following steps:

1. Form a guess about $\theta_j^s\lambda_j^s$ and compute $n_{ij}^s(v)$ and $\ln\bar{\tilde{x}}_{ij}^s(v)$.

2. Estimate equation (3.16) for each $\{sj\}$ by OLS, where $\ln \frac{\sigma^s c_s f_{ij}^s}{1-\theta_j^s}$ is a constant,[7] and $\theta_j^s$ is estimated as a parameter on $\ln\left[1-\Pr_{ij}^s(v)\right]$.

3. Reformulate equation (3.14) as

$$\ln\left[\frac{\bar{x}_{ij}^s(v)}{\bar{x}_{ij}^s}\right] = -\theta_j^s \ln\left[1-\Pr_{ij}^s(v)\right] + \ln\left[\frac{1-\theta_j^s}{\theta_j^s \lambda_j^s} n_{ij}^s(v) + 1\right] + \varepsilon_{vij}^s \, ,$$

use the just-obtained estimate of $\theta_j^s$ therein and estimate $\theta_j^s \lambda_j^s$.

4. With the estimated $\theta_j^s \lambda_j^s$, repeat until convergence.

The results corresponding to this procedure are summarized in Tables 3.2 to 3.6. Each of the tables corresponds to one sector and contains six column blocks of which four pertain to results for the above model and two pertain to a Melitz-Chaney-type model (indicated by superscript *fixed* without imperfect market penetration, where $\lambda \to \infty$). In each column block, we report point estimates and standard errors in parentheses for estimated parameters but, for the sake of brevity, only point estimates for derived/computed parameters.[8] Note that, given that there is no trade (or an insufficient number of observations) in a few country-sector combinations, involving mostly small economies, there are some empty lines in Tables 3.3, 3.4 and 3.6. As our services-transactions dataset does not cover bilateral trade in manufactures and other sectors and we know about the domestic sales (Germany) and global exports (Rest of the World) only from firm-level financial statements of German firms, we summarize the corresponding results more compactly in Table 3.7 and Table 3.8.

As all other parameters in Tables 3.2 to 3.6 are composites, we focus on a summary of the results regarding the shape parameters of the market penetration cost function in the model of interest here, $\widehat{\lambda}_j^s$, and of the firm-efficiency distribution, $\widehat{k}_j^s$, for the same model as well as the Melitz-Chaney-type model.

Recall that a lower (higher) value of $\lambda_j^s$ means that relatively fewer (more) customers are reached at lower (higher) corresponding market penetration costs. Across the five services sectors in Tables 3.2 to 3.6, the average value of $\widehat{\lambda}_j^s$ is highest for Transport Services (0.77) and lowest for Other Services (0.33).[9] The range of $\widehat{\lambda}_j^s$ is very large across targeted countries and spans

[7] Note that the only country $i$ in this estimation is Germany, so that $f_{ij}^s$ is a constant parameter.

[8] We run the above procedure using 100 different starting values for $\theta_j^s \lambda_j^s$. For the sake of faster convergence, we set the parameter space of $\theta_j^s \lambda_j^s$ at $[0.001, 1000.000]$. In some cases the estimate $\theta_j^s \lambda_j^s$ is at the lower bound of the considered parameter space. However, this is of limited importance, as the boundary problem of $\theta_j^s \lambda_j^s$ is mainly absorbed by and reflected in the estimate of $\lambda_j^s$, whereas it influences the estimate of $\theta_j^s$ to a lesser extent. For the counterfactual analysis, $\widehat{\theta}_j^s$ matters but not $\widehat{\lambda}_j^s$.

[9] Notice that the moments of $\lambda_j^s$ we refer to are calculated from slightly different samples of countries across the tables.

Table 3.2: Estimates of $\theta_j^s$, $\lambda_j^s$ and $k_j^s$ Using Transaction-level Data, Transport Services

| Country | Main Model | | | | | | Fixed Cost Model | | |
|---|---|---|---|---|---|---|---|---|---|
| | $\widehat{\theta_j^s \lambda_j^s}$ | | $\widehat{\theta}_j^s$ | | $\widehat{\lambda}_j^s$ | $\widehat{k}_j^s$ | $\left(\widehat{\theta}_j^s\right)^{\text{fix}}$ | | $\left(\widehat{k}_j^s\right)^{\text{fix}}$ |
| Australia | 0.862 | (0.268) | 0.893 | (0.068) | 0.965 | 4.663 | 0.887 | (0.013) | 4.696 |
| Austria | 0.378 | (0.045) | 0.754 | (0.030) | 0.502 | 5.524 | 0.830 | (0.014) | 5.016 |
| Belgium | 0.421 | (0.030) | 0.733 | (0.025) | 0.574 | 5.684 | 0.801 | (0.013) | 5.196 |
| Brazil | 0.457 | (0.194) | 0.837 | (0.065) | 0.547 | 4.977 | 0.891 | (0.012) | 4.674 |
| Bulgaria | 0.732 | (0.310) | 0.821 | (0.129) | 0.892 | 5.071 | 0.839 | (0.019) | 4.963 |
| Canada | 0.589 | (0.287) | 0.893 | (0.093) | 0.659 | 4.665 | 0.909 | (0.010) | 4.579 |
| China | 0.449 | (0.140) | 0.857 | (0.057) | 0.524 | 4.857 | 0.897 | (0.013) | 4.640 |
| Croatia | 0.892 | (0.395) | 0.829 | (0.103) | 1.076 | 5.025 | 0.843 | (0.020) | 4.938 |
| Cyprus | 0.380 | (0.076) | 0.653 | (0.045) | 0.583 | 6.379 | 0.765 | (0.022) | 5.443 |
| Czech Republic | 0.518 | (0.068) | 0.799 | (0.034) | 0.648 | 5.213 | 0.837 | (0.014) | 4.976 |
| Denmark | 0.329 | (0.063) | 0.712 | (0.047) | 0.462 | 5.847 | 0.815 | (0.016) | 5.111 |
| Estonia | 0.362 | (0.185) | 0.630 | (0.097) | 0.575 | 6.612 | 0.770 | (0.024) | 5.410 |
| Finland | 0.416 | (0.066) | 0.658 | (0.046) | 0.631 | 6.325 | 0.755 | (0.019) | 5.516 |
| France | 0.244 | (0.059) | 0.690 | (0.038) | 0.354 | 6.031 | 0.822 | (0.010) | 5.062 |
| Germany | 0.468 | (0.184) | 0.843 | (0.090) | 0.555 | 4.937 | 0.886 | (0.010) | 4.699 |
| Greece | 0.001 | (0.000) | 0.517 | (0.063) | 0.002 | 8.050 | 0.871 | (0.011) | 4.779 |
| Hungary | 0.527 | (0.141) | 0.780 | (0.063) | 0.675 | 5.335 | 0.829 | (0.016) | 5.022 |
| India | 1.097 | (0.268) | 0.910 | (0.063) | 1.205 | 4.577 | 0.888 | (0.015) | 4.689 |
| Indonesia | 0.685 | (0.308) | 0.801 | (0.104) | 0.855 | 5.196 | 0.846 | (0.020) | 4.920 |
| Ireland | 0.382 | (0.076) | 0.596 | (0.050) | 0.641 | 6.988 | 0.722 | (0.019) | 5.768 |
| Italy | 0.390 | (0.082) | 0.810 | (0.049) | 0.481 | 5.142 | 0.871 | (0.016) | 4.780 |
| Japan | 0.376 | (0.136) | 0.757 | (0.064) | 0.497 | 5.502 | 0.844 | (0.013) | 4.931 |
| Korea | 0.553 | (0.080) | 0.765 | (0.037) | 0.722 | 5.441 | 0.809 | (0.018) | 5.149 |
| Latvia | 0.394 | (0.178) | 0.584 | (0.117) | 0.675 | 7.129 | 0.722 | (0.030) | 5.765 |
| Lithuania | 0.001 | (0.002) | 0.583 | (0.044) | 0.002 | 7.142 | 0.867 | (0.012) | 4.802 |
| Luxembourg | 0.323 | (0.129) | 0.768 | (0.056) | 0.421 | 5.422 | 0.864 | (0.012) | 4.821 |
| Malta | 0.514 | (0.301) | 0.673 | (0.162) | 0.764 | 6.187 | 0.774 | (0.029) | 5.382 |
| Mexico | 0.913 | (0.234) | 0.881 | (0.045) | 1.035 | 4.724 | 0.880 | (0.016) | 4.731 |
| Netherlands | 0.352 | (0.022) | 0.716 | (0.025) | 0.491 | 5.815 | 0.805 | (0.013) | 5.170 |
| Norway | 0.322 | (0.093) | 0.679 | (0.059) | 0.474 | 6.133 | 0.798 | (0.018) | 5.220 |
| Poland | 0.371 | (0.105) | 0.830 | (0.042) | 0.447 | 5.014 | 0.892 | (0.007) | 4.666 |
| Portugal | 0.001 | (0.088) | 0.540 | (0.078) | 0.002 | 7.716 | 0.807 | (0.017) | 5.158 |
| Romania | 0.720 | (0.264) | 0.865 | (0.088) | 0.833 | 4.816 | 0.870 | (0.015) | 4.784 |
| Russian Federation | 0.462 | (0.121) | 0.803 | (0.058) | 0.575 | 5.183 | 0.855 | (0.015) | 4.869 |
| Slovakia | 0.810 | (0.180) | 0.821 | (0.053) | 0.987 | 5.074 | 0.824 | (0.019) | 5.054 |
| Slovenia | 0.647 | (0.351) | 0.840 | (0.156) | 0.770 | 4.955 | 0.870 | (0.013) | 4.787 |
| Spain | 0.392 | (0.065) | 0.752 | (0.043) | 0.522 | 5.540 | 0.828 | (0.016) | 5.030 |
| Sweden | 0.446 | (0.048) | 0.733 | (0.032) | 0.609 | 5.678 | 0.799 | (0.014) | 5.209 |
| Switzerland | 0.297 | (0.044) | 0.713 | (0.032) | 0.416 | 5.836 | 0.822 | (0.012) | 5.063 |
| Taiwan | 0.391 | (0.140) | 0.669 | (0.079) | 0.584 | 6.224 | 0.781 | (0.018) | 5.329 |
| Turkey | 0.456 | (0.093) | 0.770 | (0.052) | 0.592 | 5.407 | 0.830 | (0.017) | 5.016 |
| United Kingdom | 0.001 | (0.009) | 0.665 | (0.038) | 0.002 | 6.259 | 0.903 | (0.006) | 4.612 |
| United States of America | 0.375 | (0.138) | 0.890 | (0.054) | 0.421 | 4.678 | 0.930 | (0.007) | 4.478 |
| Rest of the World | 0.346 | (0.067) | 0.861 | (0.041) | 0.401 | 4.835 | 0.912 | (0.011) | 4.566 |

Table 3.3: Estimates of $\theta_j^s$, $\lambda_j^s$ and $k_j^s$ Using Transaction-level Data, Construction Services

| | Main Model | | | | | | Fixed Cost Model | | |
|---|---|---|---|---|---|---|---|---|---|
| Country | $\widehat{\theta_j^s\lambda_j^s}$ | | $\widehat{\theta}_j^s$ | | $\widehat{\lambda}_j^s$ | $\widehat{k}_j^s$ | $\left(\widehat{\theta}_j^s\right)^{\text{fix}}$ | | $\left(\widehat{k}_j^s\right)^{\text{fix}}$ |
| Australia | | | | | | | | | |
| Austria | 0.193 | (0.114) | 0.651 | (0.074) | 0.296 | 7.676 | 0.819 | (0.014) | 6.101 |
| Belgium | 0.481 | (0.031) | 0.519 | (0.034) | 0.927 | 9.626 | 0.622 | (0.025) | 8.031 |
| Brazil | | | | | | | | | |
| Bulgaria | | | | | | | | | |
| Canada | | | | | | | | | |
| China | 0.963 | (0.279) | 0.791 | (0.084) | 1.218 | 6.321 | 0.795 | (0.025) | 6.284 |
| Croatia | | | | | | | | | |
| Cyprus | | | | | | | | | |
| Czech Republic | 0.607 | (0.111) | 0.631 | (0.056) | 0.961 | 7.913 | 0.703 | (0.030) | 7.104 |
| Denmark | 0.232 | (0.138) | 0.571 | (0.090) | 0.406 | 8.758 | 0.764 | (0.022) | 6.544 |
| Estonia | | | | | | | | | |
| Finland | 0.835 | (0.245) | 0.717 | (0.089) | 1.165 | 6.973 | 0.759 | (0.038) | 6.581 |
| France | 0.571 | (0.128) | 0.782 | (0.055) | 0.730 | 6.388 | 0.823 | (0.017) | 6.070 |
| Germany | 0.247 | (0.026) | 0.561 | (0.029) | 0.440 | 8.909 | 0.725 | (0.015) | 6.888 |
| Greece | | | | | | | | | |
| Hungary | 0.001 | (0.019) | 0.395 | (0.061) | 0.003 | 12.651 | 0.747 | (0.027) | 6.687 |
| India | | | | | | | | | |
| Indonesia | | | | | | | | | |
| Ireland | | | | | | | | | |
| Italy | 0.728 | (0.288) | 0.805 | (0.108) | 0.905 | 6.211 | 0.825 | (0.020) | 6.054 |
| Japan | | | | | | | | | |
| Korea | | | | | | | | | |
| Latvia | | | | | | | | | |
| Lithuania | | | | | | | | | |
| Luxembourg | 0.219 | (0.110) | 0.535 | (0.070) | 0.410 | 9.348 | 0.734 | (0.022) | 6.805 |
| Malta | | | | | | | | | |
| Mexico | | | | | | | | | |
| Netherlands | 0.370 | (0.038) | 0.561 | (0.030) | 0.659 | 8.909 | 0.689 | (0.019) | 7.249 |
| Norway | 1.525 | (33.422) | 0.809 | (0.077) | 1.886 | 6.180 | 0.779 | (0.044) | 6.410 |
| Poland | 0.365 | (0.090) | 0.545 | (0.054) | 0.668 | 9.161 | 0.695 | (0.024) | 7.194 |
| Portugal | | | | | | | | | |
| Romania | 2.170 | (51.521) | 0.861 | (0.112) | 2.520 | 5.802 | 0.819 | (0.033) | 6.104 |
| Russian Federation | 0.070 | (0.067) | 0.682 | (0.069) | 0.103 | 7.327 | 0.883 | (0.011) | 5.656 |
| Slovakia | | | | | | | | | |
| Slovenia | | | | | | | | | |
| Spain | 0.001 | (0.056) | 0.523 | (0.096) | 0.002 | 9.550 | 0.830 | (0.016) | 6.022 |
| Sweden | 0.541 | (0.127) | 0.684 | (0.061) | 0.791 | 7.307 | 0.763 | (0.030) | 6.552 |
| Switzerland | 0.345 | (0.097) | 0.617 | (0.067) | 0.560 | 8.096 | 0.747 | (0.023) | 6.692 |
| Taiwan | | | | | | | | | |
| Turkey | 0.420 | (0.236) | 0.663 | (0.120) | 0.634 | 7.537 | 0.788 | (0.024) | 6.340 |
| United Kingdom | 0.556 | (0.053) | 0.659 | (0.034) | 0.844 | 7.588 | 0.719 | (0.023) | 6.947 |
| United States of America | 0.782 | (0.298) | 0.787 | (0.087) | 0.993 | 6.348 | 0.813 | (0.027) | 6.143 |
| Rest of the World | 0.551 | (0.103) | 0.794 | (0.042) | 0.694 | 6.292 | 0.834 | (0.016) | 5.991 |

Table 3.4: Estimates of $\theta_j^s$, $\lambda_j^s$ and $k_j^s$ Using Transaction-level Data, ICT Services

| | Main Model | | | | | | Fixed Cost Model | | |
|---|---|---|---|---|---|---|---|---|---|
| Country | $\widehat{\theta_j^s \lambda_j^s}$ | | $\widehat{\theta}_j^s$ | | $\widehat{\lambda}_j^s$ | $\widehat{k}_j^s$ | $\left(\widehat{\theta}_j^s\right)^{\text{fix}}$ | | $\left(\widehat{k}_j^s\right)^{\text{fix}}$ |
| Australia | 0.001 | (0.124) | 0.581 | (0.119) | 0.002 | 5.020 | 0.839 | (0.014) | 3.475 |
| Austria | 0.001 | (0.017) | 0.541 | (0.027) | 0.002 | 5.392 | 0.817 | (0.008) | 3.568 |
| Belgium | 0.272 | (0.075) | 0.620 | (0.047) | 0.439 | 4.705 | 0.768 | (0.014) | 3.794 |
| Brazil | 0.242 | (0.177) | 0.627 | (0.115) | 0.386 | 4.650 | 0.794 | (0.024) | 3.672 |
| Bulgaria | 0.396 | (0.222) | 0.677 | (0.134) | 0.585 | 4.306 | 0.811 | (0.020) | 3.596 |
| Canada | 0.001 | (0.004) | 0.461 | (0.059) | 0.002 | 6.327 | 0.809 | (0.015) | 3.605 |
| China | 0.172 | (0.093) | 0.625 | (0.058) | 0.276 | 4.663 | 0.807 | (0.012) | 3.613 |
| Croatia | 0.001 | (0.036) | 0.542 | (0.066) | 0.002 | 5.380 | 0.839 | (0.016) | 3.473 |
| Cyprus | | | | | | | | | |
| Czech Republic | 0.407 | (0.130) | 0.761 | (0.067) | 0.535 | 3.830 | 0.838 | (0.015) | 3.477 |
| Denmark | 0.449 | (0.089) | 0.723 | (0.048) | 0.621 | 4.033 | 0.798 | (0.016) | 3.655 |
| Estonia | | | | | | | | | |
| Finland | 0.001 | (0.025) | 0.598 | (0.049) | 0.002 | 4.875 | 0.860 | (0.014) | 3.390 |
| France | 0.350 | (0.044) | 0.732 | (0.030) | 0.478 | 3.984 | 0.821 | (0.012) | 3.551 |
| Germany | 0.162 | (0.132) | 0.676 | (0.086) | 0.240 | 4.314 | 0.846 | (0.013) | 3.446 |
| Greece | 0.001 | (0.002) | 0.449 | (0.077) | 0.002 | 6.497 | 0.837 | (0.015) | 3.483 |
| Hungary | 0.532 | (0.118) | 0.753 | (0.054) | 0.706 | 3.872 | 0.808 | (0.020) | 3.608 |
| India | 0.369 | (0.202) | 0.775 | (0.101) | 0.477 | 3.763 | 0.864 | (0.013) | 3.374 |
| Indonesia | 0.001 | (0.014) | 0.276 | (0.073) | 0.004 | 10.549 | 0.684 | (0.031) | 4.260 |
| Ireland | 0.197 | (0.108) | 0.699 | (0.054) | 0.281 | 4.168 | 0.852 | (0.013) | 3.423 |
| Italy | 0.284 | (0.077) | 0.662 | (0.050) | 0.429 | 4.403 | 0.794 | (0.016) | 3.671 |
| Japan | 0.290 | (0.135) | 0.654 | (0.072) | 0.443 | 4.455 | 0.799 | (0.019) | 3.648 |
| Korea | 0.057 | (0.141) | 0.555 | (0.121) | 0.102 | 5.256 | 0.808 | (0.020) | 3.609 |
| Latvia | | | | | | | | | |
| Lithuania | | | | | | | | | |
| Luxembourg | 0.342 | (0.110) | 0.687 | (0.056) | 0.498 | 4.244 | 0.802 | (0.017) | 3.634 |
| Malta | | | | | | | | | |
| Mexico | 0.194 | (0.173) | 0.598 | (0.122) | 0.324 | 4.876 | 0.791 | (0.023) | 3.683 |
| Netherlands | 0.079 | (0.068) | 0.661 | (0.045) | 0.119 | 4.410 | 0.855 | (0.009) | 3.411 |
| Norway | 0.287 | (0.167) | 0.573 | (0.118) | 0.501 | 5.089 | 0.748 | (0.026) | 3.896 |
| Poland | 0.016 | (0.076) | 0.543 | (0.068) | 0.029 | 5.372 | 0.803 | (0.014) | 3.629 |
| Portugal | 0.454 | (0.089) | 0.607 | (0.053) | 0.747 | 4.800 | 0.715 | (0.023) | 4.079 |
| Romania | 0.460 | (0.146) | 0.673 | (0.076) | 0.684 | 4.333 | 0.767 | (0.020) | 3.801 |
| Russian Federation | 0.403 | (0.108) | 0.675 | (0.059) | 0.598 | 4.318 | 0.776 | (0.020) | 3.755 |
| Slovakia | 0.486 | (0.100) | 0.623 | (0.056) | 0.780 | 4.680 | 0.720 | (0.024) | 4.046 |
| Slovenia | 0.273 | (0.213) | 0.636 | (0.129) | 0.430 | 4.580 | 0.810 | (0.021) | 3.599 |
| Spain | 0.001 | (0.001) | 0.623 | (0.031) | 0.002 | 4.676 | 0.892 | (0.008) | 3.267 |
| Sweden | 0.382 | (0.124) | 0.767 | (0.060) | 0.498 | 3.801 | 0.848 | (0.014) | 3.436 |
| Switzerland | 0.169 | (0.074) | 0.666 | (0.051) | 0.253 | 4.375 | 0.831 | (0.012) | 3.510 |
| Taiwan | 0.001 | (0.000) | 0.298 | (0.065) | 0.003 | 9.775 | 0.732 | (0.031) | 3.982 |
| Turkey | 0.439 | (0.080) | 0.634 | (0.047) | 0.693 | 4.598 | 0.734 | (0.018) | 3.973 |
| United Kingdom | 0.382 | (0.052) | 0.804 | (0.031) | 0.475 | 3.624 | 0.866 | (0.011) | 3.367 |
| United States of America | 0.095 | (0.085) | 0.700 | (0.056) | 0.136 | 4.164 | 0.873 | (0.010) | 3.339 |
| Rest of the World | 0.289 | (0.103) | 0.775 | (0.052) | 0.373 | 3.762 | 0.871 | (0.011) | 3.345 |

Table 3.5: Estimates of $\theta_j^s$, $\lambda_j^s$ and $k_j^s$ Using Transaction-level Data, Other Business Services

| | Main Model | | | | | | Fixed Cost Model | | |
|---|---|---|---|---|---|---|---|---|---|
| Country | $\widehat{\theta_j^s \lambda_j^s}$ | | $\widehat{\theta}_j^s$ | | $\widehat{\lambda}_j^s$ | $\widehat{k}_j^s$ | $\left(\widehat{\theta}_j^s\right)^{\text{fix}}$ | | $\left(\widehat{k}_j^s\right)^{\text{fix}}$ |
| Australia | 0.258 | (0.067) | 0.630 | (0.050) | 0.409 | 5.571 | 0.779 | (0.016) | 4.508 |
| Austria | 0.178 | (0.029) | 0.636 | (0.031) | 0.280 | 5.523 | 0.804 | (0.013) | 4.366 |
| Belgium | 0.272 | (0.049) | 0.779 | (0.038) | 0.349 | 4.509 | 0.874 | (0.013) | 4.020 |
| Brazil | 0.179 | (0.107) | 0.640 | (0.084) | 0.279 | 5.488 | 0.812 | (0.023) | 4.323 |
| Bulgaria | 0.288 | (0.072) | 0.505 | (0.058) | 0.570 | 6.951 | 0.682 | (0.021) | 5.147 |
| Canada | 0.158 | (0.104) | 0.658 | (0.080) | 0.241 | 5.337 | 0.830 | (0.020) | 4.229 |
| China | 0.273 | (0.061) | 0.793 | (0.047) | 0.344 | 4.429 | 0.883 | (0.015) | 3.977 |
| Croatia | 0.297 | (0.049) | 0.461 | (0.040) | 0.644 | 7.616 | 0.640 | (0.019) | 5.485 |
| Cyprus | 0.001 | (0.079) | 0.652 | (0.120) | 0.002 | 5.388 | 0.903 | (0.006) | 3.889 |
| Czech Republic | 0.126 | (0.112) | 0.739 | (0.095) | 0.170 | 4.750 | 0.888 | (0.020) | 3.953 |
| Denmark | 0.195 | (0.066) | 0.637 | (0.057) | 0.307 | 5.516 | 0.803 | (0.019) | 4.376 |
| Estonia | 0.001 | (0.000) | 0.329 | (0.057) | 0.003 | 10.665 | 0.765 | (0.015) | 4.591 |
| Finland | 0.257 | (0.056) | 0.626 | (0.051) | 0.410 | 5.609 | 0.776 | (0.019) | 4.528 |
| France | 0.171 | (0.036) | 0.689 | (0.026) | 0.248 | 5.097 | 0.842 | (0.008) | 4.172 |
| Germany | 0.268 | (0.055) | 0.598 | (0.051) | 0.448 | 5.874 | 0.750 | (0.022) | 4.685 |
| Greece | 0.161 | (0.074) | 0.511 | (0.045) | 0.316 | 6.878 | 0.728 | (0.015) | 4.821 |
| Hungary | 0.001 | (0.028) | 0.702 | (0.040) | 0.001 | 5.005 | 0.912 | (0.005) | 3.850 |
| India | 0.172 | (0.062) | 0.594 | (0.041) | 0.289 | 5.913 | 0.780 | (0.012) | 4.500 |
| Indonesia | 0.352 | (0.077) | 0.586 | (0.052) | 0.602 | 5.994 | 0.723 | (0.021) | 4.857 |
| Ireland | 0.306 | (0.087) | 0.802 | (0.048) | 0.382 | 4.381 | 0.884 | (0.012) | 3.973 |
| Italy | 0.274 | (0.016) | 0.662 | (0.019) | 0.415 | 5.306 | 0.785 | (0.010) | 4.475 |
| Japan | 0.319 | (0.045) | 0.756 | (0.028) | 0.422 | 4.646 | 0.847 | (0.010) | 4.146 |
| Korea | 0.330 | (0.061) | 0.727 | (0.044) | 0.454 | 4.829 | 0.825 | (0.014) | 4.259 |
| Latvia | 0.394 | (0.054) | 0.415 | (0.045) | 0.950 | 8.465 | 0.584 | (0.026) | 6.018 |
| Lithuania | 0.185 | (0.137) | 0.481 | (0.101) | 0.384 | 7.295 | 0.714 | (0.026) | 4.917 |
| Luxembourg | 0.334 | (0.030) | 0.709 | (0.027) | 0.471 | 4.951 | 0.805 | (0.014) | 4.363 |
| Malta | 0.049 | (0.077) | 0.557 | (0.062) | 0.089 | 6.308 | 0.809 | (0.020) | 4.343 |
| Mexico | 0.059 | (0.136) | 0.712 | (0.118) | 0.083 | 4.934 | 0.892 | (0.015) | 3.937 |
| Netherlands | 0.277 | (0.020) | 0.733 | (0.025) | 0.378 | 4.789 | 0.839 | (0.013) | 4.188 |
| Norway | 0.310 | (0.038) | 0.621 | (0.029) | 0.500 | 5.659 | 0.749 | (0.013) | 4.687 |
| Poland | 0.053 | (0.055) | 0.617 | (0.048) | 0.086 | 5.694 | 0.834 | (0.012) | 4.213 |
| Portugal | 0.094 | (0.105) | 0.660 | (0.083) | 0.143 | 5.322 | 0.852 | (0.014) | 4.121 |
| Romania | 0.001 | (0.000) | 0.552 | (0.031) | 0.002 | 6.358 | 0.875 | (0.007) | 4.012 |
| Russian Federation | 0.251 | (0.045) | 0.647 | (0.037) | 0.388 | 5.429 | 0.789 | (0.013) | 4.449 |
| Slovakia | 0.405 | (0.054) | 0.725 | (0.035) | 0.558 | 4.842 | 0.803 | (0.016) | 4.375 |
| Slovenia | 0.289 | (0.087) | 0.561 | (0.070) | 0.515 | 6.256 | 0.725 | (0.024) | 4.841 |
| Spain | 0.142 | (0.065) | 0.675 | (0.050) | 0.210 | 5.206 | 0.843 | (0.013) | 4.166 |
| Sweden | 0.258 | (0.041) | 0.677 | (0.031) | 0.381 | 5.189 | 0.807 | (0.011) | 4.353 |
| Switzerland | 0.337 | (0.021) | 0.858 | (0.015) | 0.392 | 4.092 | 0.908 | (0.007) | 3.867 |
| Taiwan | 0.325 | (0.130) | 0.695 | (0.085) | 0.468 | 5.057 | 0.812 | (0.020) | 4.328 |
| Turkey | 0.004 | (0.046) | 0.502 | (0.048) | 0.009 | 7.003 | 0.777 | (0.014) | 4.521 |
| United Kingdom | 0.258 | (0.025) | 0.756 | (0.022) | 0.342 | 4.645 | 0.860 | (0.009) | 4.082 |
| United States of America | 0.266 | (0.036) | 0.826 | (0.034) | 0.322 | 4.254 | 0.905 | (0.013) | 3.883 |
| Rest of the World | 0.332 | (0.014) | 0.741 | (0.014) | 0.449 | 4.739 | 0.825 | (0.008) | 4.254 |

Table 3.6: Estimates of $\theta_j^s$, $\lambda_j^s$ and $k_j^s$ Using Transaction-level Data, Other Services

| | Main Model | | | | | | Fixed Cost Model | | |
|---|---|---|---|---|---|---|---|---|---|
| Country | $\widehat{\theta_j^s \lambda_j^s}$ | | $\widehat{\theta}_j^s$ | | $\widehat{\lambda}_j^s$ | $\widehat{k}_j^s$ | $\left(\widehat{\theta}_j^s\right)^{\text{fix}}$ | | $\left(\widehat{k}_j^s\right)^{\text{fix}}$ |
| Australia | 0.649 | (0.131) | 0.913 | (0.028) | 0.710 | 2.488 | 0.917 | (0.008) | 2.479 |
| Austria | 0.307 | (0.041) | 0.813 | (0.029) | 0.377 | 2.794 | 0.888 | (0.010) | 2.560 |
| Belgium | 0.388 | (0.043) | 0.833 | (0.021) | 0.466 | 2.728 | 0.884 | (0.009) | 2.571 |
| Brazil | 0.564 | (0.111) | 0.889 | (0.034) | 0.634 | 2.556 | 0.904 | (0.009) | 2.514 |
| Bulgaria | 0.506 | (0.071) | 0.705 | (0.039) | 0.718 | 3.224 | 0.771 | (0.018) | 2.949 |
| Canada | 0.589 | (0.072) | 0.869 | (0.023) | 0.678 | 2.615 | 0.883 | (0.011) | 2.573 |
| China | 0.424 | (0.065) | 0.886 | (0.024) | 0.479 | 2.564 | 0.918 | (0.008) | 2.477 |
| Croatia | 0.446 | (0.056) | 0.670 | (0.030) | 0.666 | 3.394 | 0.759 | (0.023) | 2.993 |
| Cyprus | 0.430 | (0.220) | 0.761 | (0.110) | 0.566 | 2.987 | 0.845 | (0.016) | 2.690 |
| Czech Republic | 0.238 | (0.080) | 0.740 | (0.043) | 0.322 | 3.071 | 0.860 | (0.009) | 2.643 |
| Denmark | 0.299 | (0.100) | 0.759 | (0.062) | 0.393 | 2.994 | 0.858 | (0.015) | 2.648 |
| Estonia | 0.493 | (0.178) | 0.607 | (0.097) | 0.812 | 3.742 | 0.716 | (0.027) | 3.174 |
| Finland | 0.258 | (0.132) | 0.684 | (0.084) | 0.377 | 3.321 | 0.821 | (0.020) | 2.767 |
| France | 0.285 | (0.094) | 0.863 | (0.054) | 0.330 | 2.633 | 0.925 | (0.012) | 2.456 |
| Germany | 0.245 | (0.019) | 0.733 | (0.022) | 0.334 | 3.100 | 0.849 | (0.010) | 2.678 |
| Greece | 0.284 | (0.108) | 0.815 | (0.041) | 0.349 | 2.790 | 0.902 | (0.011) | 2.519 |
| Hungary | 0.408 | (0.064) | 0.794 | (0.029) | 0.514 | 2.864 | 0.854 | (0.011) | 2.660 |
| India | 0.468 | (0.156) | 0.870 | (0.067) | 0.538 | 2.611 | 0.902 | (0.012) | 2.520 |
| Indonesia | 0.264 | (0.205) | 0.738 | (0.116) | 0.357 | 3.080 | 0.864 | (0.014) | 2.630 |
| Ireland | 0.240 | (0.124) | 0.853 | (0.059) | 0.282 | 2.666 | 0.930 | (0.005) | 2.443 |
| Italy | 0.389 | (0.049) | 0.869 | (0.024) | 0.448 | 2.615 | 0.909 | (0.007) | 2.499 |
| Japan | 0.310 | (0.132) | 0.870 | (0.053) | 0.356 | 2.611 | 0.929 | (0.006) | 2.447 |
| Korea | 0.489 | (0.117) | 0.837 | (0.044) | 0.584 | 2.715 | 0.878 | (0.011) | 2.589 |
| Latvia | 0.437 | (0.147) | 0.640 | (0.082) | 0.683 | 3.553 | 0.752 | (0.025) | 3.023 |
| Lithuania | 0.341 | (0.191) | 0.618 | (0.118) | 0.552 | 3.679 | 0.770 | (0.021) | 2.950 |
| Luxembourg | 0.371 | (0.044) | 0.831 | (0.029) | 0.446 | 2.736 | 0.886 | (0.011) | 2.565 |
| Malta | 0.002 | (0.039) | 0.631 | (0.047) | 0.003 | 3.600 | 0.867 | (0.015) | 2.620 |
| Mexico | 0.133 | (0.094) | 0.830 | (0.046) | 0.160 | 2.739 | 0.938 | (0.005) | 2.422 |
| Netherlands | 0.360 | (0.044) | 0.860 | (0.023) | 0.419 | 2.643 | 0.908 | (0.008) | 2.504 |
| Norway | 0.150 | (0.117) | 0.770 | (0.070) | 0.195 | 2.952 | 0.902 | (0.009) | 2.519 |
| Poland | 0.374 | (0.044) | 0.794 | (0.026) | 0.471 | 2.864 | 0.858 | (0.009) | 2.648 |
| Portugal | 0.471 | (0.101) | 0.808 | (0.047) | 0.583 | 2.813 | 0.855 | (0.013) | 2.659 |
| Romania | 0.394 | (0.095) | 0.777 | (0.048) | 0.507 | 2.925 | 0.850 | (0.013) | 2.673 |
| Russian Federation | 0.350 | (0.067) | 0.800 | (0.028) | 0.437 | 2.841 | 0.872 | (0.007) | 2.608 |
| Slovakia | 0.342 | (0.097) | 0.709 | (0.049) | 0.481 | 3.204 | 0.815 | (0.013) | 2.788 |
| Slovenia | 0.001 | (0.027) | 0.640 | (0.037) | 0.002 | 3.553 | 0.871 | (0.015) | 2.609 |
| Spain | 0.327 | (0.058) | 0.821 | (0.030) | 0.398 | 2.768 | 0.891 | (0.008) | 2.552 |
| Sweden | 0.374 | (0.059) | 0.786 | (0.037) | 0.475 | 2.891 | 0.855 | (0.012) | 2.658 |
| Switzerland | 0.267 | (0.061) | 0.865 | (0.030) | 0.309 | 2.628 | 0.929 | (0.007) | 2.446 |
| Taiwan | 0.354 | (0.212) | 0.783 | (0.094) | 0.453 | 2.903 | 0.872 | (0.016) | 2.608 |
| Turkey | 0.449 | (0.080) | 0.853 | (0.033) | 0.526 | 2.666 | 0.891 | (0.011) | 2.551 |
| United Kingdom | 0.204 | (0.137) | 0.905 | (0.067) | 0.226 | 2.511 | 0.961 | (0.006) | 2.366 |
| United States of America | 0.285 | (0.120) | 0.918 | (0.052) | 0.310 | 2.475 | 0.957 | (0.009) | 2.375 |
| Rest of the World | 0.335 | (0.122) | 0.932 | (0.048) | 0.359 | 2.438 | 0.959 | (0.007) | 2.369 |

Table 3.7: Estimates of $\theta_j^s$, $\lambda_j^s$ and $k_j^s$ Using Firm-level Data, Manufacturing

| | Main Model | | | | | | Fixed Cost Model | | |
|---|---|---|---|---|---|---|---|---|---|
| Country | $\widehat{\theta_j^s \lambda_j^s}$ | | $\widehat{\theta}_j^s$ | | $\widehat{\lambda}_j^s$ | $\widehat{k}_j^s$ | $\left(\widehat{\theta}_j^s\right)^{\text{fix}}$ | | $\left(\widehat{k}_j^s\right)^{\text{fix}}$ |
| Germany | 0.051 | (0.033) | 0.619 | (0.032) | 0.082 | 6.225 | 0.837 | (0.012) | 4.607 |
| Rest of the World | 0.087 | (0.072) | 0.773 | (0.062) | 0.113 | 4.985 | 0.916 | (0.015) | 4.209 |

Table 3.8: Estimates of $\theta_j^s$, $\lambda_j^s$ and $k_j^s$ Using Firm-level Data, Other Sectors (n.c.e.)

| | Main Model | | | | | | Fixed Cost Model | | |
|---|---|---|---|---|---|---|---|---|---|
| Country | $\widehat{\theta_j^s \lambda_j^s}$ | | $\widehat{\theta}_j^s$ | | $\widehat{\lambda}_j^s$ | $\widehat{k}_j^s$ | $\left(\widehat{\theta}_j^s\right)^{\text{fix}}$ | | $\left(\widehat{k}_j^s\right)^{\text{fix}}$ |
| Germany | 0.199 | (0.017) | 0.726 | (0.017) | 0.274 | 9.156 | 0.857 | (0.008) | 7.761 |
| Rest of the World | 0.001 | (0.013) | 0.775 | (0.036) | 0.001 | 8.575 | 0.951 | (0.003) | 6.988 |

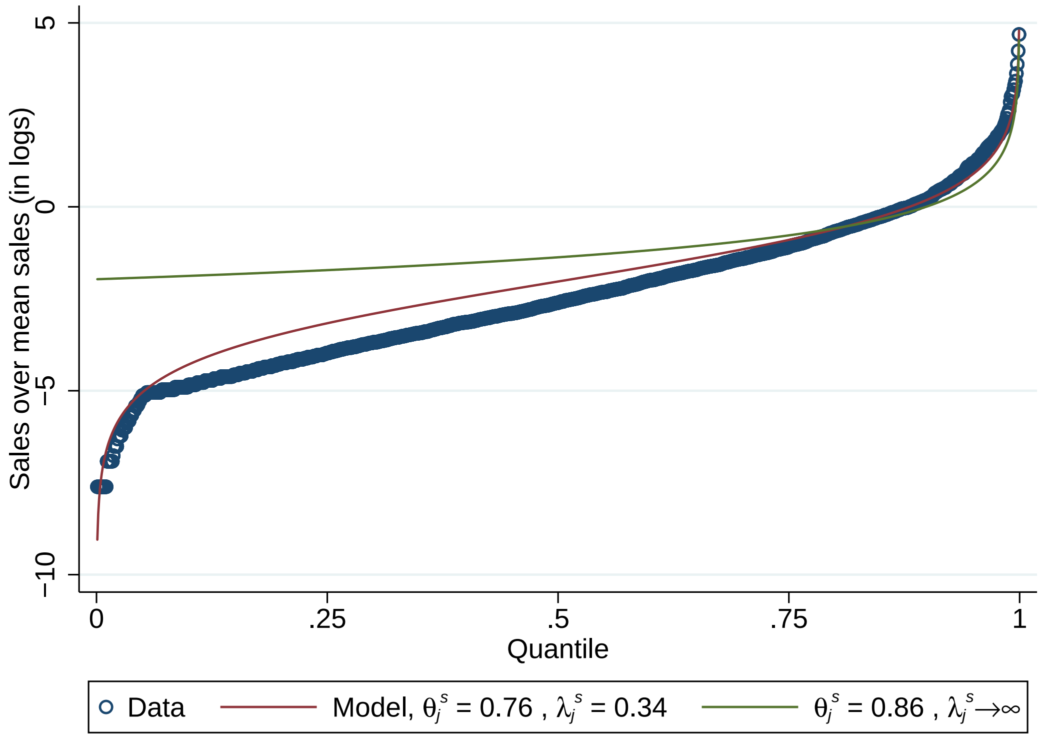
an interval from about the lower bound of the considered support to about 2.52 for exports of Construction Services to Romania and 1.21 for exports of Transport Services to India.

Notice that a smaller value of $k_j^s$ means that the density of small productivity levels of firms is relatively lower compared to high productivity levels. The average implied value of $\widehat{k}_j^s$ across countries varies among the services sectors between 2.90 for Other Services and 7.86 for Construction Services. Hence, extremely productive service producers emerge on average more likely with Other Services than for Construction Services. The range of the estimates $\widehat{k}_j^s$ across countries is with $[2.44, 3.74]$ relatively small for Other Services and with [3.6210.55] relatively wide for ICT Services. This suggests that allowing for productivity distributions that differ across targeted markets is important. When comparing the Melitz-Chaney-type model with the one proposed here, two things stand out regarding $\widehat{k}_j^s$: First, the country-sector-specific point estimates are smaller, on average; second, the range across targeted countries is considerably more narrow for all sectors.

In Figure 3.1 we plot firms' log sales over mean sales of Other Business Services to the United Kingdom against the respective quantiles of the distribution as well the estimated theoretical counterpart. We find that the model captures the sales of large and small firm sales very well, though there is some overprediction of sales for firms between the first and seventh decile.[10] We contrast these findings with the estimates for the Melitz-Chaney-type of set-up. As Figure 3.1 shows, a model that does not allow for firm-specific market penetration is not able to explain the cross-border activity of the majority of firms trading smaller volumes that we observe for German services exporters.

[10] Results for other trading partners and service sectors are qualitatively very similar.

Figure 3.1: Model Fit, Export Sales of Other Business Services to the United Kingdom

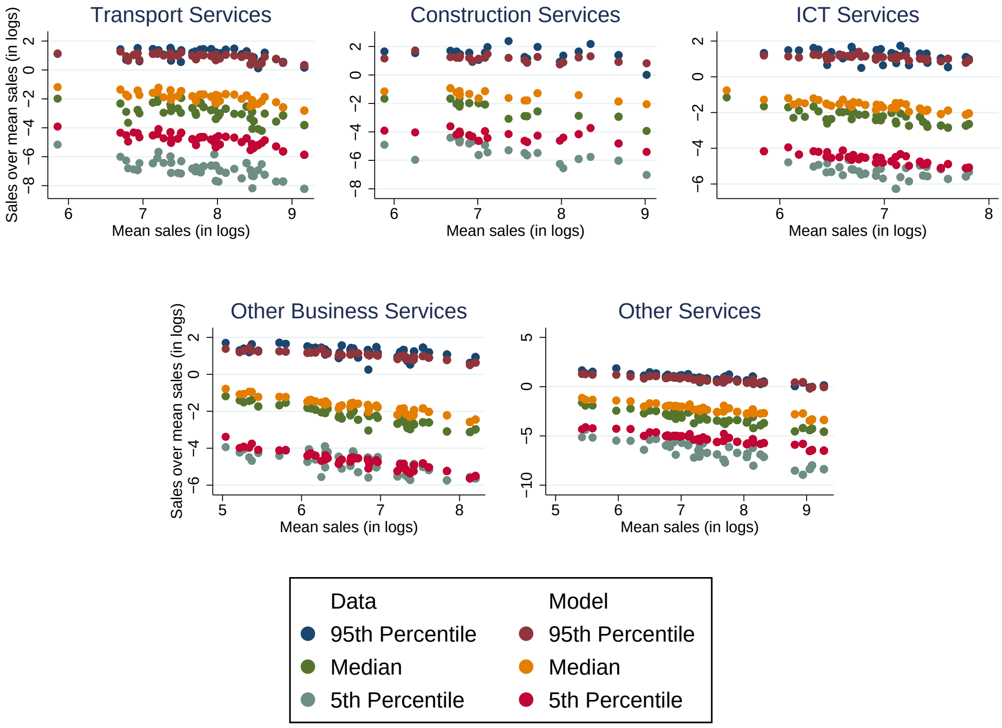



*Note*: Due to the confidential nature of the data, each dot corresponds to the mean of three adjacent ranked sales.

Next, we compare the model fit across all trading partners by services sector. Figure 3.2 shows log sales over mean sales by the top and lower five percent of firms as well the median firms plotted against log mean sales. Our model captures the cross-section of firms' exports across all traded volumes and service sectors quite well with the only two exceptions being the Transport and Other Services sectors, where there is some overprediction for firms trading smaller volumes.

For manufactures in Table 3.7, the estimate of $\widehat{\lambda}_j^s$ is with 0.082 within the range of estimates with the services sectors (e.g., the estimate for Germany and Construction Services is 0.681 in Table 3.3), and the one for the Rest of the World in Table 3.7 is with a value of 0.330 considerably smaller than the one for Germany. The values of $\widehat{k}_j^s$ for Germany and the Rest of the World in Table 3.7 are estimated at 6.23 and 4.96, respectively. The value of $\widehat{k}_j^s$ for Germany is relatively high in comparison to the ones for the services sectors (except for Construction Services, where it is 8.91), suggesting that high-productivity firms in German Manufactures for Germany are relatively less frequent than the ones for services, except for Construction Services.

Figure 3.2: Model Fit of German Services Exports by Sector



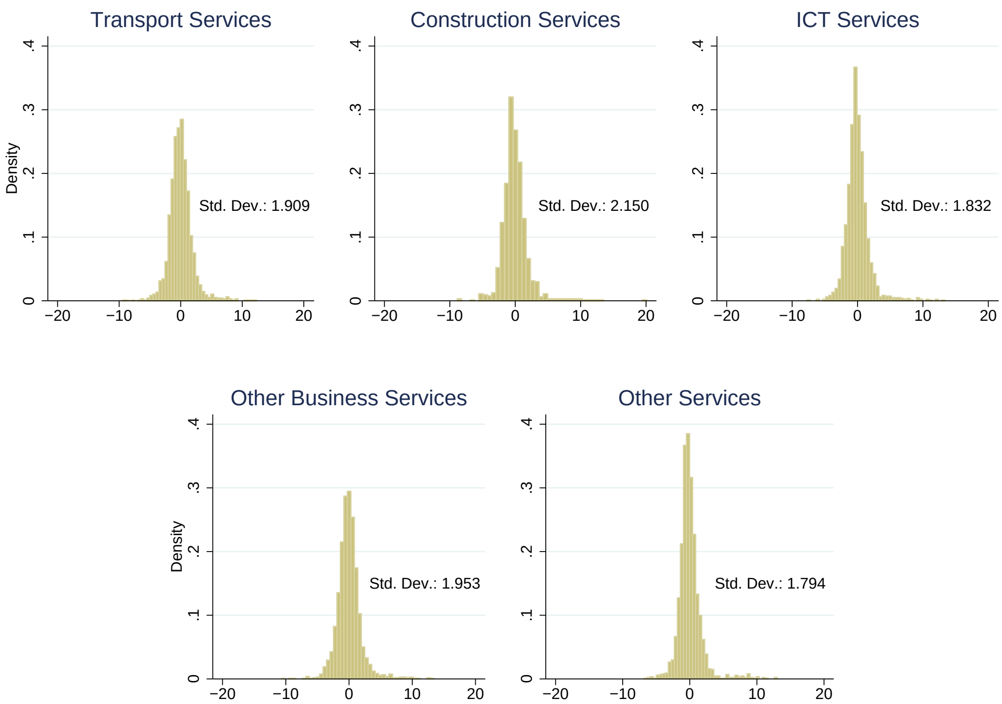

*Note*: Due to the confidential nature of the data, each dot corresponds to the mean of three adjacent ranked sales.

### 3.4.3 Estimation and Decomposition of $\zeta_{ij}^s$

In this subsection, we outline how $\zeta_{ij}^s$, which encompasses the fixed component of the market penetration cost function, $f_{ij}^s$, and the iceberg-type trade cost parameter, $\tau_{ij}^s$, is parameterized and quantified. For this, consider the market share of aggregate services exports from country $i$ to country $j$ in sector $s$, $\mu_{ij}^s$, as given by equation (3.12). The parameters $\zeta_{ij}^s$ can be estimated as the residuals from a log-linear regression of $\mu_{ij}^s$ on the following variables: an $i$-specific country effect that reflects $\ln \mathcal{M}_i$; an $sj$-specific effect that reflects the log-transformed denominator of $\mu_{ij}^s$; $k_j^s$, whose $si$-specific parameter is $\ln b_i^s$; and $1 - \frac{1}{\theta_j^s} - k_j^s$ whose $si$-specific parameter is $\ln c_i^s$.

Clearly, this fixed-effects procedure obtains values of $\ln \widehat{\zeta_{ij}^s}$ which are centered around zero in all sectors. However, the dispersion of $\ln \widehat{\zeta_{ij}^s}$ is not degenerate. We portray the distribution of $\ln \widehat{\zeta_{ij}^s}$ across the five considered services sectors by way of histograms in Figure 3.3. The standard deviation across country relationships ranges from 1.79 for Other Services to 2.15 for

Figure 3.3: Distribution of $\ln \widehat{\zeta}_{ij}^s$ by Sector




Construction Services. We exploit this dispersion to investigate the role of major factors of influence behind $\zeta_{ij}^s$ such as geography or services trade policy in the following.

We use $\ln \widehat{\zeta}_{ij}^s$ and regress it on five candidate explanatory variables: a binary services-trade-agreement indicator, $STA_{ij}$;[11] log bilateral distance between the economic centers of two countries; a binary land contiguity indicator variable, an official common language indicator, and an ethnic common language indicator. Let us collect these five regressors into the vector $Z_{ij}$, where the first element is $STA_{ij}$.

Towards decomposing $\zeta_{ij}^s$, we estimate a log-linear regression of the form[12]

$$\ln \widehat{\zeta}_{ij}^s \quad = \quad Z_{ij}\beta^{s,Z} + u_{ij}^{s,Z} \,,$$

where for inference one has to take into account that $\widehat{\zeta}_{ij}^s$ is estimated (and "measured") with error. Then, the first element of the estimates $\widehat{\beta}^{s,Z} = [\widehat{\beta}^{s,STA}, ...]'$ is informative of the impact

[11]This indicator is unity for all country pairs which are members of a pure services-trade agreement or of a general trade agreement with services-trade provisions according to information at the World Trade Organization.

[12]As the dependent variable of interest, $\ln \widehat{\zeta}_{ij}^s$ is already centered around zero, there is no need for including a constant in the model.

of STA provisions on $\widehat{\zeta}_{ij}^s$. As the latter is inversely related to obstacles to cross-border trade, we would hypothesize that $\beta^{s,STA} > 0$.

The parameters (and correctly size-adjusted standard errors) from the respective regression for each sector are summarized in Table 3.9. The table suggests that membership in an STA is relatively least important for Construction Services and relatively most important for Other Business Services. The parameters on land-border contiguity and common ethnic language are even bigger.[13] The parameter on (log) distance is negative and relatively small in absolute value.[14]

Table 3.9: Decomposing Log Scaled Inverse Trade and Market Access Costs Using Bilateral Country-level Data

| Sector | Services Trade Agreement | | Distance | | Contiguity | | Official Language | | Ethnic Language | |
|---|---|---|---|---|---|---|---|---|---|---|
| Transport | 0.311 | (0.032) | -0.058 | (0.002) | 1.387 | (0.049) | -0.370 | (0.047) | 0.770 | (0.062) |
| Construction Services | 0.119 | (0.023) | -0.045 | (0.002) | 0.803 | (0.068) | -0.321 | (0.102) | 0.531 | (0.136) |
| ICT Services | 0.301 | (0.038) | -0.056 | (0.003) | 0.996 | (0.023) | 0.195 | (0.036) | 0.357 | (0.036) |
| Other Business Services | 0.323 | (0.020) | -0.055 | (0.002) | 0.910 | (0.040) | -0.014 | (0.039) | 0.303 | (0.071) |
| Other Services | 0.222 | (0.038) | -0.051 | (0.003) | 1.111 | (0.049) | 0.260 | (0.063) | 0.128 | (0.077) |

*Notes*: Bootstrapped standard errors are in parentheses.

Table 3.10: Impact of Services Trade Agreements on Log Scaled Inverse Trade and Market Access Costs and Its Distance Equivalent

| | Percentage Change | |
|---|---|---|
| Sector | Decrease in $\zeta_{ij}^s$ | Distance Equivalent |
| Transport | -26.734 | 461.635 |
| Construction Services | -11.229 | 248.905 |
| ICT Services | -25.957 | 465.557 |
| Other Business Services | -27.573 | 501.632 |
| Other Services | -19.933 | 388.547 |

In Table 3.10 we convert the point estimates $\widehat{\beta}^{s,STA} > 0$ into semi-elasticities in percent and compute the distance equivalent in percent. The corresponding numbers suggest that the termination of the membership in an STA boosts overall scaled trade costs in a range of 11.23 percent

[13]The parameter on common official language is hard to interpret, since we always condition on ethnic language. In every case where the official-common-language indicator is unity, the ethnic-common-language indicator is as well.

[14]Relative to the literature on gravity models based on aggregate trade, in particular the coefficient on log distance appears small, see the meta-study in Head and Mayer (2014). However, using less aggregated data tends to result in lower point estimates in absolute value, see e.g. Crozet and Koenig (2010).

(in Construction Services) and 27.57 percent (in Other Services). The distance equivalent to exiting an STA membership corresponds to an increase in distance between 243.33 percent (in Construction Services) and 487.97 percent (in Other Business Services) among STA partners.

## 3.5 General Equilibrium

In general equilibrium, factor prices respond endogenously to shocks in the economy. In order to gauge the magnitude of the responses it is important to consider the well-documented input-output structure of economies where services play a prominent role, see the WIOT.[15] We follow Caliendo and Parro (2015) in implementing this input-output structure based on the model of Eaton and Kortum (2002).

### 3.5.1 The Structure of Production and Demand

In each country $i$ and sector $s$ there is a unit measure of perfectly competitive firms which bundle a composite good that is a CES-basket of individual varieties belonging to sector $s$ from $J$ countries:

$$Q_i^s = \left\{ \sum_{j=1}^{J} \int_{\phi_{ji}^{s*}}^{\infty} \left[q_{ji}^s(v)\right]^{\frac{\sigma^s-1}{\sigma^s}} g(\phi_{ji}^s) d\phi_{ji}^s \right\}^{\frac{\sigma^s}{\sigma^s-1}},$$

where $q_{ji}^s(v)$ is the quantity of output purchased from firm $v$ located in country $j$.[16] Demand for an individual variety of firm $v$ which reaches a fraction of $n_{ji}^s(v)$ buyers in country $i$ is given by

$$q_{ji}^s(v) = n_{ji}^s(v) \frac{\left[p_{ji}^s(v)\right]^{-\sigma^s}}{\left(P_i^s\right)^{1-\sigma^s}} E_i^s\,,$$

where total expenditure on varieties of sector $s$ in country $i$ correspond to $E_i^s = P_i^s Q_i^s$. $P_i^s$ is the sectoral price index,

$$\begin{aligned} P_i^s &= \left\{ \sum_{j=1}^{J} M_{ji}^s \int_{\phi_{ji}^{s*}}^{\infty} n_{ji}^s(v) \left[p_{ji}^s(v)\right]^{1-\sigma^s} g(\phi_{ji}^s) d\phi_{ji}^s \right\}^{\frac{1}{1-\sigma^s}} \\ &= \left[ \Theta_i^s \sum_{j=1}^{J} M_{ji}^s \left( \frac{\sigma^s}{\sigma^s-1} \frac{c_j^s \tau_{ji}^s}{\phi_{ji}^{s*}} \right)^{1-\sigma^s} \right]^{\frac{1}{1-\sigma^s}}. \end{aligned}$$

[15] World Input-Output Tables (WIOT).

[16] We think of the quantity of a service input to be a similar concept to labor and capital-services input in manufacturing goods production. In that sense, the quantity of such an input is well defined. Consequently, the price of a service input is the cost per efficiency unit of a purchased service.

The composite good may be used for final consumption or as an input for other domestic firms. To produce any output of services or goods, firms use labour and intermediates with a Cobb-Douglas technology. To produce $y_i^s(v)$ units, firm $v$ in country $i$ combines $\ell_i^s(v)$ units of labour and intermediates of each sector $z$, $q_i^{zs}(v)$,

$$y_i^s(v) = \phi(v) \left[ \frac{\ell_i^s(v)}{\gamma_i^s} \right]^{\gamma_i^s} \prod_{z=1}^{S} \left[ \frac{q_i^{zs}(v)}{\gamma_i^{zs}} \right]^{\gamma_i^{zs}} ,$$

where $\gamma_i^{zs}$ is the input share of the composite intermediate goods or services inputs from sector $z$ in sector $s$ and country $i$. The parameters $\gamma_i^s$ and $\sum_{z=1}^{S} \gamma_i^{zs} = 1 - \gamma_i^s$ denote the value added shares accruing to labour and intermediates, respectively.The cost per unit of $y_i^s(v)$ is given by

$$c_i^s = (w_i^s)^{\gamma_i^s} \prod_{z=1}^{S} (P_i^z)^{\gamma_i^{zs}} ,$$

where $w_i^s$ are sector-specific wages. We assume that households' upper-tier utility function is Cobb-Douglas and of the form

$$U(\mathcal{C}_i) = \prod_{s=1}^{S} (\mathcal{C}_i^s)^{\alpha_i^s} ,$$

with aggregate consumption of output from sector $s$, $\mathcal{C}_i^s$, and $\sum_{s=1}^{S} \alpha_i^s = 1$. While $P_i^s$ is the ideal price index for sector-$s$ consumption in country $i$, the ideal price index in that country for consumption at large (across all sectors) is given by

$$P_i = \prod_{s=1}^{S} \left( \frac{P_i^s}{\alpha_i^s} \right)^{\alpha_i^s} .$$

### 3.5.2 Labour Market Clearing and Trade Balance

Labour market clearing implies that the wage bill in country $i$ for producing a variety of sector $s$ equals the labour earnings from production, $\gamma_i^s \sum_{j=1}^{J} \frac{\sigma^s - 1}{\sigma^s} X_{ij}^s$, plus labour earning from market penetration, $\gamma_i^s \sum_{j=1}^{J} \frac{1-\theta_j^s}{\sigma^s} X_{ij}^s$,

$$w_i^s L_i^s = \gamma_i^s \sum_{j=1}^{J} \left( \frac{\sigma^s - 1}{\sigma^s} X_{ij}^s + \frac{1 - \theta_j^s}{\sigma^s} X_{ij}^s \right) = \gamma_i^s \sum_{j=1}^{J} \frac{\sigma^s - \theta_j^s}{\sigma^s} X_{ij}^s . \quad (3.18)$$

Aggregate expenditures in country $i$ for goods or services of sector $s$ are given by the sum of firms' spending on intermediates of sector $s$ and a share $\alpha_i^s$ of households' overall income, which is given by the aggregate wage bill and dividends net of the share of the trade balance, net-exports $B_i$, that is spent on sector $s$-output, denoted by $B_i^s$. Hence, the trade balance is a lump-sum transfer (possibly negative) to households. Sectoral expenditures are then given by

$$E_i^s = \sum_{j=1}^{J} X_{ji}^s = \alpha_i^s \left( \sum_{z=1}^{S} w_i^z L_i^z + \sum_{z=1}^{S} \sum_{j=1}^{J} M_{ij}^z \bar{\pi}_{ij}^z \right) - B_i^s + \sum_{z=1}^{S} \gamma_i^{sz} \sum_{j=1}^{J} \frac{\sigma^z - \theta_j^z}{\sigma^z} X_{ij}^z \,. \quad (3.19)$$

We assume that each country's trade balance is a constant multiple of aggregate spending, whereby $B_i^s = \beta_i^s \sum_{s=1}^{S} E_i^s$, to ensure that trade imbalances are scaled by a country's economic size. Using equations (3.11) and (3.18), (3.19) can be written as

$$E_i^s = \alpha_i^s \left( \sum_{z=1}^{S} \sum_{j=1}^{J} \frac{\gamma_i^z \sigma^z + (1 - \gamma_i^z)\theta_j^z}{\sigma^z} \mu_{ij}^s E_j^z \right) - \beta_i^s \sum_{z=1}^{S} E_i^z + \sum_{z=1}^{S} \gamma_i^{sz} \sum_{j=1}^{J} \frac{\sigma^z - \theta_j^z}{\sigma^z} \mu_{ij}^z E_j^z \,, \quad (3.20)$$

where the market share of country $i$ exporting varieties of sector $s$ to country $j$, $\mu_{ij}^s$, is given by equation (3.12).

### 3.5.3 Changes in Endogenous Variables

For any generic variable $h$, $h'$ denotes its counterfactual value and $\dot{h}$ denotes the ratio of counterfactual and benchmark values with $\dot{h} \equiv h'/h$, with $h' = \dot{h}h$.

Using equation (3.12), the change in the market share of country $i$ supplying varieties of sector $s$ in country $j$ is given by

$$\dot{\mu}_{ij}^s = \frac{\left(\dot{c}_i^s\right)^{1 - \frac{1}{\theta_j^s} - k_j^s} \dot{\zeta}_{ij}^s}{\sum_{l=1}^{J} \mu_{lj}^s \left(\dot{c}_l^s\right)^{1 - \frac{1}{\theta_j^s} - k_j^s} \dot{\zeta}_{lj}^s} \,.$$

Note that, given the exponents, $\dot{\mu}_{ij}^s$ depends on the endogenous $\dot{c}_i^s$ and the exogenous $\dot{\zeta}_{ji}^s = \left(\dot{\tau}_{ij}^s\right)^{-k_{ij}^s} \left(\dot{f}_{ij}^s\right)^{1 - \frac{1}{\theta_{ij}^s}}$ only. Using equation (3.20), changes in sectoral expenditures in country $i$ are given by

$$\begin{aligned} \dot{E}_i^s E_i^s = {} & \alpha_i^s \left( \sum_{z=1}^{S} \sum_{j=1}^{J} \frac{\gamma_i^z \sigma^z + (1 - \gamma_i^z)\theta_j^z}{\sigma^z} \dot{\mu}_{ij}^z \dot{E}_j^z \mu_{ij}^z E_j^z \right) - \beta_i^s \sum_{z=1}^{S} \dot{E}_i^z E_i^z \\ & + \sum_{z=1}^{S} \sum_{j=1}^{J} \gamma_i^{sz} \frac{\sigma^z - \theta_j^z}{\sigma^z} \dot{\mu}_{ij}^z \dot{E}_j^z \mu_{ij}^z E_j^z \,. \end{aligned}$$

Factor costs evolve according to

$$\dot{c}_i^s = \left(\dot{w}_i^s\right)^{\gamma_i^s} \prod_{z=1}^{S} \left(\dot{P}_i^z\right)^{\gamma_i^{zs}} \,,$$

with

$$\left(\dot{P}_i^s\right)^{1-\sigma^s} = \sum_{j=1}^{J} \mu_{ji}^s \dot{M}_{ji}^s \left(\frac{\dot{c}_j^s \dot{\tau}_{ji}^s}{\dot{\phi}_{ji}^{s*}}\right)^{1-\sigma^s} \tag{3.21}$$

$$= \left(\dot{E}_i^s\right)^{1-\theta_i^s} \sum_{j=1}^{J} \mu_{ji}^s \left(\dot{\mu}_{ji}^s\right)^{1-\theta_i^s} \left(\dot{c}_j^s\right)^{\theta_i^s-(\sigma^s-1)} \left(\dot{\zeta}_{ji}^s\right)^{1-\theta_i^s} . \tag{3.22}$$

We assume that the measure of potential entrants in each country $i$, $\mathcal{M}_i$, and its overall technology level for providing varieties of different sectors to individual countries $j$, $b_i^s$, are invariant to changes in trade costs. It then follows from equation (3.5) that changes in the measure of active firms and the underlying cut-off efficiency levels are directly linked through $\dot{\phi}_{ij}^{s*} = (\dot{M}_{ij}^s)^{-1/k_j^s}$. Apart from that, we have used that the change in overall exports of country $i$ to market $j$ of varieties of sector $s$ are given by $\dot{X}_{ij}^s = \dot{\mu}_{ij}^s \dot{E}_j^s = \dot{M}_{ij}^s \dot{c}_i^s \dot{f}_{ij}^s$, so that $\dot{M}_{ij}^s = \dot{\mu}_{ij}^s \dot{E}_j^s / (\dot{c}_i^s \dot{f}_{ij}^s)$. Accordingly, equation (3.21) can be expressed as equation (3.22).

We assume that labour is immobile across sectors and that the number of employees within sectors is unaffected by trade liberalization. Then, $\dot{w}_i^s$ can be derived from equation (3.18) as

$$\dot{w}_i^s = \frac{\gamma_i^s}{w_i^s L_i^s} \sum_{j=1}^{J} \dot{\mu}_{ij}^s \dot{E}_j^s \frac{\sigma^s - \theta_j^s}{\sigma^s} \mu_{ij}^s E_j^s .$$

Using $\eta_{ij}^s = \frac{(\sigma^s - \theta_j^s) X_{ij}^s}{\sum_{j=1}^{J} (\sigma^s - \theta_j^s) X_{ij}^s}$, the latter can be expressed as

$$\dot{w}_i^s = \sum_{j=1}^{J} \eta_{ij}^s \dot{\mu}_{ij}^s \dot{E}_j^s .$$

Changes in nominal dividends are given by

$$\dot{\Pi}_i^s = \sum_{j=1}^{J} \kappa_{ij}^s \dot{\mu}_{ij}^s \dot{E}_j^s ,$$

with $\kappa_{ij}^s = \frac{\theta_j^s X_{ij}^s}{\sum_{j=1}^{J} \theta_l^s X_{ij}^s}$.

Upon a choice of a suitable set of $S$ numéraires, the system of equations in this subsection can be solved uniquely for changes in the endogenous outcomes of interest in response to shocks in, e.g., $\zeta_{ij}^s$. For computational convenience, we choose the $S$ values of $\dot{E}_i^s$ for the Rest of the World as our numéraires.

## 3.6 Quantitative Counterfactual Analysis of De-liberalizations of Preferential Services-Market Access

We organise this section into two subsections, one is dedicated to the description of the counterfactual experiments we undertake and the other one summarises the findings from these experiments.

### 3.6.1 Counterfactual Experiments

In the counterfactual analysis, we will consider three alternative types of experiments. In the first one, we consider the case where one specific country at a time abandons all its existing services-trade-agreement memberships (STAs) with all its trading partners in the data. There, for one specific country that appears as an exporter, $i$, and as an importer $j$, in the data, we consider the case where $\dot{\zeta}_{ij}^s = \exp(-\widehat{\beta}^{s,STA} STA_{ij})$ if *either* $i$ *or* $j$ is that country (not when $i = j$). Clearly, the associated effects should be expected to be bigger the more preferential trading partners they have. However, the general equilibrium effects will also depend on technology, endowments, the pattern of $\dot{\zeta}_{ij}^s$ as well as the input-output structure of the economies in the outset. In the second experiment, we abandon all existing STAs jointly rather than removing them for individual countries one at a time. Hence, we consider the case, where $\dot{\zeta}_{ij}^s = \exp(-\widehat{\beta}^{s,STA} STA_{ij})$ for all country pairs $ij$ with $i \neq j$. We expect the effects of this to be larger on average than the ones with the first experiment. In the third experiment, we consider the case where $\dot{\zeta}_{ij}^s = \exp(-\widehat{\beta}^{s,STA})$ for all country pairs $ij$ with $i \neq j$, irrespective of whether they have preferential services trade provisions in place or not. Hence, in comparison to the second experiment, the binary indicator variable $STA_{ij}$ is absent in the exponent $\dot{\zeta}_{ij}^s = \exp(\cdot)$. This serves to gauge insights into the quantitative impact of an increase in services trade costs to an extent that corresponds to the one of abandoning an existing STA (no matter whether an STA is in place or not). Clearly, as the latter experiment is of a non-discriminatory nature (among foreign trade partners), the associated effects should be largest in comparison to the other experiments.

As for the consequences of the aforementioned types of changes for real economic outcomes, we will consider responses in real consumption for the representative household (a utilitarian measure of welfare in this model), $U_i$, as well as sector-specific changes in real wages ($w_i^s/P_i^s$) and dividends ($\sum_{j=1}^{J} M_{ij}^s \bar{\pi}_{ij}^s / P_i^s$) which, apart from changes in real trade imbalances, real changes in household consumption depend upon.[17]

### 3.6.2 Abandoning Services-trade-agreement Membership (STA) for Selected Individual Countries

When quantifying the effects of an exit from existing STAs for individual countries, we focus on the following economies: Austria (small, centrally located, and many STA partners); Belgium (small, centrally located, many STA partners); Canada (small, peripherally located, and few

[17]Notice that both real wages and real dividends depend on the nominal sales of firms in a country and sector so that the effects on these aggregates are not independent of each other.

STA partners); France (large, centrally located, and many STA partners); Germany (large, centrally located, and many STA partners); Netherlands (small, centrally located, and many STA partners); United Kingdom (large, centrally located, and many STA partners); United States (large, peripherally located, and few STA partners). Table 3.11 reports the rank in terms of the number of STA memberships, the average distance to destination countries as well as total services expenditures among the considered countries.

Table 3.11: Rank of Considered Countries in Terms of Number of STA Members, Average Distance to Trading Partners and Total Services Expenditures

| Country | STA Members | Average Distance | Services Spending |
|---|---|---|---|
| Austria | 1 | 8 | 8 |
| Belgium | 1 | 6 | 7 |
| Canada | 5 | 1 | 5 |
| France | 1 | 4 | 4 |
| Germany | 1 | 7 | 2 |
| Netherlands | 1 | 5 | 6 |
| United Kingdom | 1 | 3 | 3 |
| United States of America | 6 | 2 | 1 |

Since all countries are connected through trade in this model, there are effects on third countries from abandoning STA membership in a single economy at a time. The magnitude of effects on the respective economies and on third countries depends on the "connectedness" of the countries in the international WIOT network. In order to capture the heterogeneity of effects, we report one table for each STA-abandoning country and, within a table, moments of the distribution of effects across partner countries (some of which are STA members with the respective country and some of which are not).[18] In each table, we summarizes the effects on real consumption across all sectors, on the real wages across sectors, and on the real dividends across sectors. The effects across sectors depend on the importance of STA membership for $\widehat{\zeta}_{ij}^{s}$, i.e., on $\widehat{\beta}^{s,STA}$, as well as on the input-output linkages between sectors, which are specific to an economy. All effects are expressed in percent and summarized in Tables 3.12 to 3.19.

In a nutshell, three key findings from this analysis stand out. First, exiting STAs is costly in terms of real household consumption, and the costs tend to be higher for smaller countries than larger ones as well as for well connected countries (more STA partners in the outset; more central countries) than for less well connected ones (fewer STA partners in the outset; more peripheral countries).

Second, the effects on third countries are largely heterogeneous and may be even bigger at

[18]Specifically, we report on the minimum (min), the 10th 50th, and 90th percentile (p10, p50, p90), and the maximum effect across third countries.

Table 3.12: Removal of Preferential Market Access for Services, Austria

| Change in | Impact on Austria | Impact on Other Countries | | | | |
|---|---|---|---|---|---|---|
| | | min | p10 | p50 | p90 | max |
| Real Consumption | | | | | | |
| All Sectors | -0.504 | -0.300 | -0.058 | -0.005 | 0.000 | 0.001 |
| Real Wages | | | | | | |
| Transport | -2.117 | -0.744 | -0.300 | -0.006 | 0.004 | 0.014 |
| Construction | -0.247 | -0.167 | -0.044 | -0.003 | 0.000 | 0.000 |
| ICT Services | -1.706 | -0.154 | -0.117 | -0.006 | 0.001 | 0.003 |
| Other Business Services | -0.936 | -0.436 | -0.087 | -0.008 | 0.000 | 0.001 |
| Other Services | -0.510 | -0.397 | -0.063 | -0.004 | 0.000 | 0.000 |
| Manufacturing | -0.247 | -0.081 | -0.016 | -0.001 | 0.000 | 0.011 |
| Other Sectors (n.c.e) | -0.244 | -0.103 | -0.019 | -0.001 | 0.000 | 0.005 |
| Real Dividends | | | | | | |
| Transport | -2.533 | -0.575 | -0.233 | -0.007 | 0.003 | 0.011 |
| Construction | -0.248 | -0.165 | -0.043 | -0.003 | 0.000 | 0.061 |
| ICT Services | -2.797 | -0.143 | -0.063 | -0.002 | 0.001 | 0.003 |
| Other Business Services | -1.034 | -0.469 | -0.091 | -0.007 | 0.000 | 0.001 |
| Other Services | -0.491 | -0.412 | -0.078 | -0.005 | 0.000 | 0.000 |
| Manufacturing | -0.248 | -0.080 | -0.016 | -0.001 | 0.001 | 0.010 |
| Other Sectors (n.c.e) | -0.244 | -0.102 | -0.018 | -0.001 | 0.001 | 0.006 |

Table 3.13: Removal of Preferential Market Access for Services, Belgium

| Change in | Impact on Belgium | Impact on Other Countries | | | | |
|---|---|---|---|---|---|---|
| | | min | p10 | p50 | p90 | max |
| Real Consumption | | | | | | |
| All Sectors | -0.902 | -0.602 | -0.042 | -0.015 | 0.000 | 0.001 |
| Real Wages | | | | | | |
| Transport | -2.467 | -0.447 | -0.200 | -0.032 | 0.006 | 0.018 |
| Construction | -0.572 | -0.260 | -0.051 | -0.008 | 0.000 | 0.000 |
| ICT Services | -2.083 | -1.450 | -0.076 | -0.018 | 0.001 | 0.001 |
| Other Business Services | -1.957 | -0.463 | -0.139 | -0.028 | 0.002 | 0.006 |
| Other Services | -0.925 | -0.813 | -0.047 | -0.015 | 0.000 | 0.000 |
| Manufacturing | -0.555 | -0.189 | -0.029 | -0.005 | 0.002 | 0.005 |
| Other Sectors (n.c.e) | -0.432 | -0.198 | -0.025 | -0.004 | 0.000 | 0.009 |
| Real Dividends | | | | | | |
| Transport | -2.722 | -0.372 | -0.144 | -0.027 | 0.005 | 0.018 |
| Construction | -0.690 | -0.248 | -0.045 | -0.006 | 0.000 | 0.022 |
| ICT Services | -2.822 | -1.215 | -0.067 | -0.016 | 0.002 | 0.009 |
| Other Business Services | -1.395 | -0.555 | -0.230 | -0.056 | 0.002 | 0.005 |
| Other Services | -0.928 | -0.788 | -0.061 | -0.016 | 0.000 | 0.000 |
| Manufacturing | -0.557 | -0.190 | -0.029 | -0.006 | 0.002 | 0.005 |
| Other Sectors (n.c.e) | -0.432 | -0.196 | -0.025 | -0.004 | 0.000 | 0.009 |

Table 3.14: Removal of Preferential Market Access for Services, Canada

| Change in | Impact on Canada | Impact on Other Countries | | | | |
|---|---|---|---|---|---|---|
| | | min | p10 | p50 | p90 | max |
| Real Consumption | | | | | | |
| All Sectors | -0.115 | -0.010 | -0.003 | 0.000 | 0.001 | 0.001 |
| Real Wages | | | | | | |
| Transport | -0.223 | -0.053 | 0.000 | 0.003 | 0.006 | 0.012 |
| Construction | -0.106 | -0.002 | -0.001 | 0.000 | 0.001 | 0.001 |
| ICT Services | -0.174 | -0.018 | -0.003 | 0.000 | 0.001 | 0.008 |
| Other Business Services | -0.338 | -0.026 | -0.003 | 0.000 | 0.001 | 0.003 |
| Other Services | -0.144 | -0.013 | -0.003 | 0.000 | 0.000 | 0.001 |
| Manufacturing | -0.071 | -0.011 | -0.001 | 0.000 | 0.000 | 0.000 |
| Other Sectors (n.c.e) | -0.054 | -0.007 | -0.001 | 0.000 | 0.000 | 0.000 |
| Real Dividends | | | | | | |
| Transport | -0.189 | -0.058 | 0.000 | 0.004 | 0.008 | 0.014 |
| Construction | -0.114 | -0.002 | -0.001 | 0.000 | 0.001 | 0.001 |
| ICT Services | -0.405 | -0.005 | -0.001 | 0.001 | 0.002 | 0.020 |
| Other Business Services | -0.637 | -0.028 | -0.001 | 0.001 | 0.001 | 0.002 |
| Other Services | -0.164 | -0.014 | -0.003 | 0.000 | 0.000 | 0.001 |
| Manufacturing | -0.071 | -0.011 | -0.001 | 0.000 | 0.000 | 0.000 |
| Other Sectors (n.c.e) | -0.054 | -0.007 | -0.001 | 0.000 | 0.000 | 0.000 |

Table 3.15: Removal of Preferential Market Access for Services, France

| Change in | Impact on France | Impact on Other Countries | | | | |
|---|---|---|---|---|---|---|
| | | min | p10 | p50 | p90 | max |
| Real Consumption | | | | | | |
| All Sectors | -0.257 | -0.651 | -0.071 | -0.018 | 0.000 | 0.001 |
| Real Wages | | | | | | |
| Transport | -1.234 | -0.673 | -0.314 | -0.034 | 0.012 | 0.032 |
| Construction | -0.135 | -0.396 | -0.093 | -0.015 | 0.000 | 0.000 |
| ICT Services | -0.432 | -1.062 | -0.119 | -0.028 | 0.001 | 0.006 |
| Other Business Services | -0.779 | -0.673 | -0.204 | -0.022 | 0.004 | 0.010 |
| Other Services | -0.210 | -0.839 | -0.055 | -0.019 | 0.000 | 0.000 |
| Manufacturing | -0.158 | -0.185 | -0.066 | -0.006 | 0.000 | 0.008 |
| Other Sectors (n.c.e) | -0.141 | -0.241 | -0.058 | -0.006 | 0.000 | 0.012 |
| Real Dividends | | | | | | |
| Transport | -1.651 | -0.420 | -0.206 | -0.021 | 0.016 | 0.038 |
| Construction | -0.135 | -0.436 | -0.094 | -0.015 | 0.000 | 0.016 |
| ICT Services | -0.409 | -1.109 | -0.125 | -0.032 | 0.002 | 0.007 |
| Other Business Services | -0.862 | -0.631 | -0.190 | -0.028 | 0.004 | 0.016 |
| Other Services | -0.206 | -0.838 | -0.053 | -0.021 | 0.000 | 0.000 |
| Manufacturing | -0.158 | -0.185 | -0.065 | -0.006 | 0.001 | 0.009 |
| Other Sectors (n.c.e) | -0.141 | -0.239 | -0.058 | -0.005 | 0.000 | 0.013 |

Table 3.16: Removal of Preferential Market Access for Services, Germany

| Change in | Impact on Germany | Impact on Other Countries | | | | |
|---|---|---|---|---|---|---|
| | | min | p10 | p50 | p90 | max |
| Real Consumption | | | | | | |
| All Sectors | -0.309 | -0.784 | -0.131 | -0.032 | 0.000 | 0.001 |
| Real Wages | | | | | | |
| Transport | -0.742 | -0.685 | -0.373 | -0.036 | 0.012 | 0.034 |
| Construction | -0.112 | -0.420 | -0.100 | -0.020 | 0.000 | 0.001 |
| ICT Services | -0.978 | -2.086 | -0.381 | -0.048 | 0.003 | 0.021 |
| Other Business Services | -0.735 | -1.038 | -0.318 | -0.049 | 0.001 | 0.013 |
| Other Services | -0.339 | -0.871 | -0.143 | -0.033 | 0.000 | 0.001 |
| Manufacturing | -0.229 | -0.242 | -0.061 | -0.011 | 0.003 | 0.037 |
| Other Sectors (n.c.e) | -0.192 | -0.249 | -0.054 | -0.008 | 0.000 | 0.031 |
| Real Dividends | | | | | | |
| Transport | -0.581 | -0.887 | -0.422 | -0.050 | 0.011 | 0.042 |
| Construction | -0.124 | -0.373 | -0.104 | -0.017 | 0.000 | 0.020 |
| ICT Services | -1.051 | -1.994 | -0.276 | -0.043 | 0.006 | 0.026 |
| Other Business Services | -1.192 | -0.653 | -0.247 | -0.032 | 0.003 | 0.053 |
| Other Services | -0.435 | -0.719 | -0.121 | -0.026 | 0.000 | 0.009 |
| Manufacturing | -0.227 | -0.241 | -0.060 | -0.011 | 0.003 | 0.039 |
| Other Sectors (n.c.e) | -0.192 | -0.246 | -0.054 | -0.008 | 0.001 | 0.031 |

Table 3.17: Removal of Preferential Market Access for Services, Netherlands

| Change in | Impact on the Netherlands | Impact on Other Countries | | | | |
|---|---|---|---|---|---|---|
| | | min | p10 | p50 | p90 | max |
| Real Consumption | | | | | | |
| All Sectors | -0.708 | -0.464 | -0.061 | -0.013 | 0.000 | 0.001 |
| Real Wages | | | | | | |
| Transport | -3.394 | -0.362 | -0.259 | 0.000 | 0.014 | 0.047 |
| Construction | -0.913 | -0.230 | -0.051 | -0.008 | 0.000 | 0.014 |
| ICT Services | -1.253 | -0.729 | -0.182 | -0.022 | 0.002 | 0.005 |
| Other Business Services | -2.246 | -0.722 | -0.211 | -0.018 | 0.002 | 0.006 |
| Other Services | -0.501 | -0.614 | -0.066 | -0.012 | 0.000 | 0.001 |
| Manufacturing | -0.131 | -0.228 | -0.065 | -0.016 | 0.001 | 0.004 |
| Other Sectors (n.c.e) | -0.109 | -0.186 | -0.043 | -0.011 | 0.000 | 0.002 |
| Real Dividends | | | | | | |
| Transport | -3.292 | -0.412 | -0.214 | -0.003 | 0.011 | 0.027 |
| Construction | -0.984 | -0.215 | -0.053 | -0.007 | 0.000 | 0.013 |
| ICT Services | -1.537 | -0.696 | -0.177 | -0.021 | 0.005 | 0.014 |
| Other Business Services | -1.678 | -0.881 | -0.241 | -0.042 | 0.002 | 0.005 |
| Other Services | -0.471 | -0.721 | -0.072 | -0.016 | 0.000 | 0.001 |
| Manufacturing | -0.133 | -0.229 | -0.066 | -0.016 | 0.001 | 0.004 |
| Other Sectors (n.c.e) | -0.110 | -0.186 | -0.042 | -0.011 | 0.000 | 0.002 |

Table 3.18: Removal of Preferential Market Access for Services, United Kingdom

| Change in | Impact on the United Kingdom | Impact on Other Countries | | | | |
|---|---|---|---|---|---|---|
| | | min | p10 | p50 | p90 | max |
| Real Consumption | | | | | | |
| All Sectors | -0.343 | -3.128 | -0.138 | -0.033 | 0.000 | 0.001 |
| Real Wages | | | | | | |
| Transport | -0.263 | -2.225 | -0.467 | -0.077 | 0.007 | 0.042 |
| Construction | -0.170 | -1.613 | -0.118 | -0.026 | 0.000 | 0.003 |
| ICT Services | -0.741 | -3.183 | -0.273 | -0.054 | 0.003 | 0.007 |
| Other Business Services | -0.953 | -2.267 | -0.228 | -0.060 | 0.003 | 0.012 |
| Other Services | -0.406 | -4.054 | -0.153 | -0.034 | 0.001 | 0.002 |
| Manufacturing | -0.084 | -0.912 | -0.075 | -0.017 | -0.001 | 0.029 |
| Other Sectors (n.c.e) | -0.121 | -1.388 | -0.070 | -0.014 | 0.000 | 0.024 |
| Real Dividends | | | | | | |
| Transport | -0.641 | -1.929 | -0.366 | -0.037 | 0.005 | 0.047 |
| Construction | -0.170 | -1.595 | -0.129 | -0.024 | 0.001 | 0.095 |
| ICT Services | -0.466 | -3.279 | -0.425 | -0.100 | 0.005 | 0.018 |
| Other Business Services | -0.730 | -2.369 | -0.399 | -0.089 | 0.005 | 0.009 |
| Other Services | -0.355 | -5.037 | -0.281 | -0.039 | 0.001 | 0.003 |
| Manufacturing | -0.082 | -0.897 | -0.075 | -0.017 | -0.001 | 0.028 |
| Other Sectors (n.c.e) | -0.121 | -1.385 | -0.069 | -0.014 | 0.000 | 0.024 |

Table 3.19: Removal of Preferential Market Access for Services, United States of America

| Change in | Impact on the USA | Impact on Other Countries | | | | |
|---|---|---|---|---|---|---|
| | | min | p10 | p50 | p90 | max |
| Real Consumption | | | | | | |
| All Sectors | -0.018 | -0.104 | -0.017 | 0.000 | 0.002 | 0.021 |
| Real Wages | | | | | | |
| Transport | -0.145 | -0.140 | -0.024 | 0.007 | 0.015 | 0.028 |
| Construction | -0.011 | -0.098 | -0.002 | 0.001 | 0.004 | 0.009 |
| ICT Services | -0.047 | -0.143 | -0.006 | 0.002 | 0.004 | 0.038 |
| Other Business Services | -0.053 | -0.319 | -0.012 | 0.001 | 0.003 | 0.013 |
| Other Services | -0.026 | -0.131 | -0.016 | 0.001 | 0.002 | 0.029 |
| Manufacturing | -0.008 | -0.073 | -0.009 | -0.001 | 0.000 | 0.004 |
| Other Sectors (n.c.e) | -0.007 | -0.057 | -0.005 | -0.001 | 0.000 | 0.004 |
| Real Dividends | | | | | | |
| Transport | -0.146 | -0.161 | -0.022 | 0.010 | 0.019 | 0.033 |
| Construction | -0.011 | -0.106 | -0.005 | 0.001 | 0.004 | 0.008 |
| ICT Services | -0.023 | -0.312 | -0.007 | 0.003 | 0.005 | 0.035 |
| Other Business Services | -0.014 | -0.601 | -0.018 | 0.001 | 0.003 | 0.010 |
| Other Services | -0.025 | -0.150 | -0.016 | 0.001 | 0.003 | 0.032 |
| Manufacturing | -0.008 | -0.073 | -0.009 | -0.001 | 0.000 | 0.004 |
| Other Sectors (n.c.e) | -0.007 | -0.057 | -0.005 | -0.001 | 0.000 | 0.004 |

the extremes in absolute value than for the exiting country at stake in a table. The latter is more likely the case for larger and less peripheral exiting countries with more STA partners in the outset (see the lower-bound effect on third countries for Germany or United Kingdom and compare it with those of other countries). Due to a redirection ("diversion") of trade through STA memberships, some third countries will benefit from removing STAs, but these effects tend to be relatively small in magnitude.

Third, the magnitude of the effects on real wages and real dividends across sectors is relatively similar on average, but there is a large degree of heterogeneity of the effects on these outcomes across sectors. Accruing to the relatively large absolute value of $\widehat{\beta}^{s,STA}$ for Other Business Services in Table 3.9, the effect is largest on average for these outcomes in this sector. The largest effects in percent are found for Belgium and the Netherlands, and the smallest ones are found for the United States. However, the degree of variation of the effects across sectors (and third countries) depends on the input-output structure of an economy. While the effects on real wages and dividends are negative on exiting countries across all services sectors, there are also sizable negative effects on these outcomes in Manufacturing, even though there are no direct effects on that sector from exiting an STA.[19]

### 3.6.3 Abandoning Services-trade-agreement Membership (STA) for All Countries Jointly

While the analysis in the previous subsection was devoted to a removal of preferential market access between a single country and its trading partners as of 2014, we quantify effects of a joint de-liberalization among all preferential trading partners in this subsection. To put the two types of experiments in perspective, notice that preferential market access entails some diversion of business transactions from countries that have a comparative advantage in doing something before trade policy due to the distortions introduced by such policy. However, this diversion is of greater importance, if preferential market access is more selective and, hence, covers fewer economies and a smaller share of the world market. De-liberalizing preferential market access for a single economy and its trading partners entails a change in market access only for a relatively limited number of trading partners in the world trade matrix. Consequently, the effects should be relatively smaller than with a de-liberalization of preferential market access for all economies jointly.

Table 3.20 summarizes the findings for this experiment, giving moments for all countries, and Table 3.21 does so for real consumption in the selected countries as considered in the previous

[19]Notice that we choose the design of the experiment such that countries only change preferential market access to services but not goods in the counterfactual analysis.

Table 3.20: Removal of Services Trade Agreement Membership For All Countries Jointly

| | Impact on All Countries | | | | |
|---|---|---|---|---|---|
| Change in | min | p10 | p50 | p90 | max |
| Real Consumption | | | | | |
| All Sectors | -8.165 | -0.924 | -0.357 | -0.014 | 0.000 |
| Real Wages | | | | | |
| Transport | -6.031 | -3.639 | -1.072 | 0.004 | 0.118 |
| Construction | -4.682 | -0.860 | -0.214 | -0.002 | 0.003 |
| ICT Services | -13.620 | -1.801 | -0.721 | 0.006 | 0.018 |
| Other Business Services | -7.883 | -2.169 | -0.774 | -0.017 | 0.002 |
| Other Services | -10.564 | -1.079 | -0.342 | -0.007 | 0.000 |
| Manufacturing | -2.456 | -0.381 | -0.162 | -0.007 | 0.039 |
| Other Sectors (n.c.e) | -3.253 | -0.371 | -0.141 | -0.001 | 0.033 |
| Real Dividends | | | | | |
| Transport | -6.608 | -3.758 | -1.191 | 0.002 | 0.124 |
| Construction | -4.545 | -0.862 | -0.199 | -0.002 | 0.196 |
| ICT Services | -13.339 | -2.586 | -0.907 | 0.005 | 0.064 |
| Other Business Services | -9.222 | -2.599 | -0.966 | -0.008 | 0.002 |
| Other Services | -11.557 | -1.485 | -0.363 | -0.007 | -0.001 |
| Manufacturing | -2.464 | -0.382 | -0.159 | -0.007 | 0.043 |
| Other Sectors (n.c.e) | -3.227 | -0.370 | -0.141 | -0.001 | 0.038 |

Table 3.21: Impact of the Removal of All Services Trade Agreement Membership on Real Consumption in Selected Countries

| Country | All Sectors |
|---|---|
| Austria | -0.489 |
| Belgium | -0.892 |
| Canada | -0.112 |
| France | -0.253 |
| Germany | -0.307 |
| Netherlands | -0.694 |
| United Kingdom | -0.338 |
| United States of America | -0.016 |

subsection. These two tables confirm exactly the above argument: for each and every country are the effects on economic outcomes bigger with a world-wide joint de-liberalization than with an individual one (for this, compare the top row of Table 3.12 to Table 3.19 with the corresponding cells in Table 3.21), and particularly so for small and less remote countries which extensively used preferential trade agreements ex ante in 2014.

Table 3.21 suggests that the effects of the considered type of de-liberalization on real consumption range from -0.02 percent to -0.49 percent for the countries at hand. These are static (one-shot, overall) responses in the present model. Relative to the rates of annual growth of real GDP of the covered economies, we might say that they correspond to a year's real income growth in the post-Economic-and-Financial-Crisis era. Hence, the effects of a de-liberalization of preferential market access in services only are not trivially small, and they spill over to economies which do not change their behavior (as they did not operate under preferential services market access in 2014) and to sectors such as manufacturing for which we keep the policy environment constant. Whether and to which extent workers and shareholders in manufacturing would be hurt by the considered de-liberalization depends on the ramifications established through the industrial input-output structure of an economy, but on average they would suffer a loss from higher services input costs.

### 3.6.4 Raising Services Trade Costs Everywhere to an Extent as if a Global Services Trade Agreement (STA) Was Abandoned

The experiments in the two previous subsections pertained to some discriminatory change – abandoning all preferential STAs of a single country versus abandoning all STAs globally. In this subsection, we envisage a non-discriminatory global increase in services trade costs. However, in order to link the results to the earlier discussion, we consider an increase in services trade costs which is equivalent to a removal of a global STA, where all countries hypothetically participate as of 2014. Accordingly, there is no diversion present with this experiment (except for diverting trade towards domestic sales). Accordingly, the associated effects should be even bigger on average as with the second experiment.

Tables 3.22 and 3.23 summarize the corresponding findings in a way akin to the previous subsection. It is apparent from a comparison of Table 3.22 with Table 3.20 and of Table 3.23 with Table 3.21 that the economic costs of such an increase in non-tariff barriers to services trade are even bigger than for a global removal of preferential market access in services. Again, the patterns across countries and sectors are similar as with the second experiment, though.

Table 3.22: Global Removal of Services Trade Agreement Membership

| | Impact on All Countries | | | | |
|---|---|---|---|---|---|
| Change in | min | p10 | p50 | p90 | max |
| **Real Consumption** | | | | | |
| All Sectors | -12.544 | -1.497 | -0.605 | -0.147 | -0.078 |
| **Real Wages** | | | | | |
| Transport | -7.910 | -6.693 | -2.026 | -0.349 | -0.033 |
| Construction | -6.929 | -1.298 | -0.398 | -0.076 | -0.019 |
| ICT Services | -17.979 | -2.761 | -1.255 | -0.205 | -0.023 |
| Other Business Services | -10.267 | -3.019 | -1.153 | -0.321 | -0.060 |
| Other Services | -16.423 | -1.437 | -0.584 | -0.131 | -0.086 |
| Manufacturing | -3.647 | -0.655 | -0.248 | -0.047 | 0.115 |
| Other Sectors (n.c.e) | -4.806 | -0.625 | -0.218 | -0.004 | 0.037 |
| **Real Dividends** | | | | | |
| Transport | -8.743 | -7.225 | -2.398 | -0.279 | -0.064 |
| Construction | -6.788 | -1.321 | -0.407 | -0.078 | -0.019 |
| ICT Services | -17.994 | -3.781 | -1.733 | -0.233 | -0.039 |
| Other Business Services | -10.394 | -3.941 | -1.479 | -0.288 | -0.063 |
| Other Services | -16.605 | -2.067 | -0.718 | -0.137 | -0.091 |
| Manufacturing | -3.653 | -0.647 | -0.242 | -0.044 | 0.130 |
| Other Sectors (n.c.e) | -4.764 | -0.623 | -0.218 | -0.003 | 0.043 |

Table 3.23: Impact of the Global Removal of Services Trade Agreement Membership on Real Consumption in Selected Countries

| Country | All Sectors |
|---|---|
| Austria | -0.649 |
| Belgium | -1.392 |
| Canada | -0.308 |
| France | -0.409 |
| Germany | -0.488 |
| Netherlands | -1.181 |
| United Kingdom | -0.592 |
| United States of America | -0.103 |

## 3.7 Conclusion

This paper provides a quantitative analysis of a multi-sector model of trade with an imperfect coverage of customers by suppliers as in Arkolakis (2010) with a special focus on services rather than goods. The structural model is informed by aggregate sector-level for multiple countries as well micro transaction-level as well as firm-level data for Germany.

The wealth of data available permits an identification of all fundamental model parameters and alludes to the variation of these parameters across sectors and, where applicable, across consumer countries. The parameter estimates support an apparently good model fit of the relevant moments of the data for the present purpose.

The estimates are then used to inform a quantitative counterfactual analysis towards assessing the relevance of economic policy. In that regard, we allude to the role of services trade agreements (STAs) as an instrument which affects the conglomerate of variable and fixed costs of cross-border services transactions. Towards an assessment of the quantitative effects of STA membership on economies through activity in services sectors, we proceed in two steps.

First, we establish a link between estimated overall (variable and fixed) transaction costs in services and find that STAs have a similar quantitative partial (direct) impact on them on average across the considered services sectors as a goods-trade-agreement membership has on trade in manufactures with the data at hand.

Second, we use the estimated increases of partial overall trade costs and quantify their impact on various economic aggregates (such as real consumption, real wages, and real dividends) across countries from individually versus jointly exiting existing STAs as of 2011. The findings suggest, as expected, that (i) smaller and less remote countries suffer bigger losses which range from about -11.3 percent to about -0.3 percent in the case of a world-wide exit from all STAs; (ii) there are non-trivial detrimental spillover effects to the manufacturing sector from abandoning services-trade provisions in trade agreements on average, depending on the input-output relationships in a country; (iii) there are effects on partner countries and third countries that may be larger than for large STA-abandoning economies; (iv) effects on real wages and on real dividends are of a similar magnitude.

We hope that these results help for a better understanding of the quantitative importance of services and of economic policy addressing them. Due to recent political developments in Europe and elsewhere, preferential market access of business transactions in trade agreements – not only in goods but also in services – is at risk. The present paper suggests that preferential services provisions alone in such agreements are relatively important. For example, for the United Kingdom, abandoning existing provisions for services in trade agreements as of 2011 would involve a loss of real consumption per capita of about 0.6 percentage points – a magnitude that is in the ballpark of a year's worth of growth of the real economy in Europe since after the Economic and Financial Crisis.

## Appendix to Chapter 3

### Services Categories

According to the IMF's BPM6 Compilation Guide (2014) services trade can be decomposed into:

- Manufacturing Services on Physical Inputs Owned by Others (formely goods trade)
- Transport Services
- Travel
- Other Services:
  - Maintenance and Repair Services
  - Construction
  - Insurance Services
  - Financial Services
  - Charges for the Use of Intellectual Property
  - Telecommunication, Computer and Information Services, ICT
  - Other Business Services:
    - Research and Development
    - Professional and Management Services
    - Technical, Trade-related and Other Business Services
    - Operating Leasing
  - Personal, Cultural and Recreational Services, Audiovisual Services; Other Personal, Culural, and Recreational Services
  - Government Goods and Services n.i.e.

We stick to this scheme with a few exceptions: First, we add Maintenance and Repair Services as well as Travel to the group of Other Services given that the sectoral counterpart in firm-level data and the WIOD is not clear. Second, given the sectoral breakdown in the WIOD, we further extract Construction, Other Business Services and Telecommunication, Computer and Information Services from the group of Other Services. Third, we add Manufacturing Services on Physical Inputs Owned by Others given that we cannot separate manufacturing services from other manufacturing activities and this item apparently is most closely related to Other Business Services.

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