Services Trade Liberalisation and Patterns of Trade in Intermediates: Determinants, Comparative Advantage and Intra-Firm Trade

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Contents

List of Tables

List of Figures

Preface

The recent economic crisis starting in autumn 2008 led not only to a large decrease in output, but it also caused an astonishingly severe fall in trade. While real GDP in the OECD area fell by 4.8 percent and 3.2 percent in the first and second quarter of 2009, trade eventually "collapsed" with OECD export volumes contracting by 15.7 percent and 14.7 percent in the first two quarters of 2009 (OECD, 2010). Besides compositional effects in terms of industries affected and the shortage in available trade finance, the role of international production networks has been at the centre of the discussion over the causes of this trade collapse. While some scholars have highlighted the role of vertical linkages and trade in intermediates as transmission mechanism for economic shocks (Bems et al., 2009), others have argued that trade within international production networks has been more resilient than other trade (Altomonte and Ottaviano, 2009).

This debate reflects the importance of international production networks for today's world economy. The central element of these networks is trade in intermediates, which connects the different production stages across countries. In this dissertation, we analyse the economic fundamentals that determine the patterns of trade in intermediates and contribute thereby to a better understanding of international production networks and provide guidance to countries regarding essential policy questions: How large is the detrimental effect of trade costs for trade in intermediates? What are the main factors that affect the comparative advantage of countries regarding trade in intermediates? Which policies can help countries to become or to remain an integral part of production networks? Does trade in intermediates differ from other trade flows? Can countries use the same policies to address trade in intermediates and trade in consumption goods? How important is the activity of multinational enterprises for production networks and trade in intermediates in particular?

This dissertation consists of four chapters, which are self-contained and can be read independently of each other.[1] In Chapter 1, we analyse services trade liberalisation, which is a

[1] Chapter 1 is joint work with Peter Egger, Chapter 2 is joint work with Sébastien Miroudot and Chapter 3 is joint work with Roberta Piermartini and Elisa Gamberoni.

prerequisite for international production networks to arise. In particular, we study the determinants of services liberalisation undertaken by countries under the General Agreement on Trade in Services (GATS) of 1995. In Chapters 2-4, we analyse different aspects of the patterns of trade in intermediates. In Chapter 2, we assess the determinants of bilateral trade in intermediate goods and services. In Chapter 3, we investigate the role of institutions and transport infrastructure as sources of comparative advantage for intermediate goods. In Chapter 4, we study trade in intermediates in the context of the activities of multinational enterprises by assessing the determinants of the share of intra-firm trade in total trade of intermediates. When analysing the determinants, the sources of comparative advantage and intra-firm trade for intermediates, we emphasise the peculiarities of intermediates and the differences in trade patterns between intermediates and final consumption goods.

In Chapter 1, we assess the determinants of services trade liberalisation as captured by the specific commitments undertaken by countries under the General Agreement on Trade in Services (GATS) of 1995. In particular, we analyse the weighted coverage ratio of commitments for the two modes of services supply cross-border supply (mode 1) and commercial presence (mode 3). We develop a new classification for the specific commitments of 106 countries regarding market access and national treatment for 155 services sectors and 4 modes of supply.[2] The classification reveals that liberalisation under the GATS was rather limited with countries scheduling commitments in only 42 out of 155 sectors on average, which corresponds to a coverage ratio of 27 percent. While high income countries made commitments in 49 percent of possible cases, middle and low income countries have coverage ratios of 20.4 percent and 9.9 percent respectively.

This chapter represents the first comprehensive assessment of the economic fundamentals determining the GATS commitments for cross-border trade and commercial presence in services across all service sectors. While general equilibrium models of trade and multinational enterprises (Markusen, 2002 and 2006; Egger, Larch and Pfaffermayr, 2007) promise largest welfare gains to small and poor economies, we find that large and rich countries scheduled more liberal commitments under the GATS. A possible explanation for these results is the lack of comprehensive domestic regulation in service sectors of poor countries. Related concerns on other policy objectives such as consumer protection and the fear of not being able to regulate in the future might have prevented developing countries from undertaking binding commitments. To take properly into account the interdependence of countries due to the fact that the GATS agreement is the outcome of multilateral negotiations, we employ spatial econometrics modelling

[2] While a similar exercise has been conducted by Hoekman (1996), this chapter goes further by applying a more sophisticated weighting scheme for mode 3.

by including the neighbours' weighted coverage ratio as explanatory variable. We find that countries are more likely to commit to more extensive liberalisations, if their natural trading partners/neighbours do so as well. Hence, there is significant herding behaviour in liberalising service transactions.

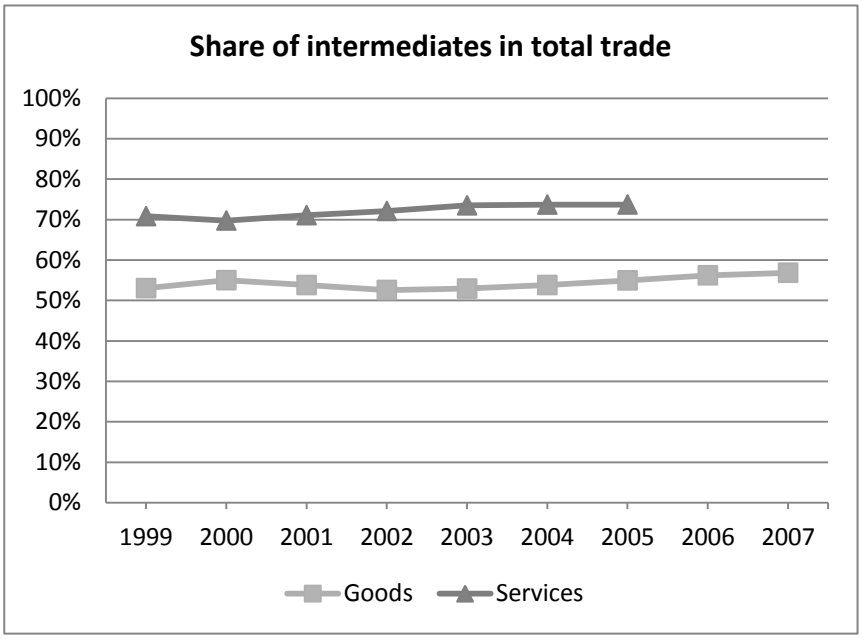
Surprisingly, empirical research on trade in intermediates has been limited so far. While some studies developed their own classification of intermediates relying on whether the terms "parts" or "components" are used in the product code (Yeats, 2001; Schott, 2003), only few studies (Bergstrand and Egger, 2010) have used the Broad Economic Categories (BEC) classification of the United Nations. In Chapters 2-4, we take advantage of this gap in the literature and employ the BEC classification to assess patterns of trade in intermediates. The BEC classification groups commodities according to their main end use into intermediate goods, capital goods and consumption goods, which are the three basic classes of goods in the System of National Accounts. While the first version of the BEC classification was issued in 1971, in our analyses, we use the fourth and most current revision of the classification that was released in 2003 and that identifies intermediates, capital goods and consumption goods in terms of the Standard International Trade Classification, Rev.3 (SITC, Rev.3) and of the Harmonized Commodity Description and Coding System, 2002 version, (HS02). By assessing the various patterns of trade in intermediates, this dissertation helps in advancing analytical results in a rather unexplored field. Moreover, we use the BEC classification as starting point to create novel datasets that allow studying new aspects of trade in intermediates. In particular, in Chapter 2 we combine trade in intermediate goods with input-output tables to create a bilateral trade dataset that includes not only the industry of origin but also the dimension of the using industry, i.e. the industry that is actually using the intermediate input in its production process. The novelty of Chapter 4 is that it combines the "use" dimension of trade as captured by the BEC classification with the ownership dimension of trade, i.e. intra-firm and arm's length trade. This allows us to provide the first analysis of intra-firm trade for intermediates, capital goods and consumption goods.

In Chapter 2 we create a comprehensive dataset of bilateral trade in intermediate goods and services for 42 countries over the period 1995-2005. By combining trade data with input-output tables, we create a novel dataset that includes i) bilateral trade in intermediate services and ii) the using industry dimension in addition to the industry of origin. This dataset allows us to obtain the very first insights into the determinants of trade in intermediate services, thereby addressing a rather unexplored field in the empirical trade literature. Furthermore, the information on both the industry of origin and the using industry enables us to estimate inter- as well as intra-industry gravity regressions.

More specifically, we use the BEC classification to identify intermediate goods at the 5-digit level of the Standard International Trade Classification (SITC), Rev.3 for a large number of countries. Unfortunately, given the high level of aggregation of services trade data, no similar classification exists for trade in services. We overcome this constraint by relying on OECD input-output tables. While input-output tables are not bilateral, they have the advantage of providing a breakdown of imported services into intermediate services and services used for final consumption. To obtain bilateral trade in services at the industry level, we multiply bilateral imports of services from trade data with the share of intermediate inputs in imported services from input-output tables. The second novelty of our dataset addresses the shortcoming that trade data are collected according to the industry of origin and give therefore no indication regarding the using industry. We again employ input-output tables to distribute bilateral trade in intermediate goods and services over using industries.

Figure 1 shows that intermediate goods and services dominate world trade, accounting for 56.2 percent of trade in goods and for 73.2 percent of trade in services in our dataset. Furthermore, it shows that the share of trade in intermediates in total trade increased only slightly during the past decade.

Figure 1: Share of intermediates in total trade



We assess the determinants of trade in intermediates using the gravity model (Anderson, 2003), which is the workhorse model in empirical trade analysis explaining bilateral trade patterns as a function of trade costs and market sizes of countries. In pooled gravity regressions, we find that trade costs matter more for intermediate goods than for consumption goods. However, in

regressions by industry the opposite pattern is found for some industries pointing to the importance of industry and product characteristics in explaining trade patterns. Finally, using instrumental variables regressions, we find a complementary relationship between bilateral inward FDI and bilateral imports of intermediates. Our findings also suggest that the impact of both trade costs and bilateral FDI is stronger on intra-industry imports than on inter-industry imports of intermediates. These results indicate that vertical production networks are more likely to be integrated within the same industry than across industries and that trade costs matter more for production stages that are closely connected. These findings open up important research questions that might be assessed more thoroughly using firm level data. For instance, Alfaro and Charlton (2009) use firm level data to show that firms are more likely to own production stages close to their own activity.

An important policy implication of our findings is that countries should aim at lowering trade costs for intermediates, since empirical research indicates that imports of intermediates can increase the productivity of domestic firms that use them (Amiti and Konings, 2007). Furthermore, our work underlines the importance of improving the collection of data on trade in intermediates for research and policymaking. For instance, accounting correctly for trade in intermediates is essential for the calculation of trade flows in value-added (Johnson and Noguera, 2009, and Daudin et al., 2009) or incorporating the different impact of trade costs on trade in intermediates and consumption goods can improve for instance the modelling of the gains from trade (Feltenstein and Plassmann, 2008).

Besides assessing the determinants of trade using gravity regressions, much empirical research in international trade has investigated whether trade flows actually follow a comparative advantage pattern. In an influential paper, Romalis (2004) predicts that a country will produce and export more in industries that use intensively those production factors the country is abundant in. Romalis empirically confirms this comparative advantage pattern of trade for traditional production factors such as physical and human capital. Recent research has emphasised that the quality of institutions and timeliness in exporting constitute alternative sources of comparative advantage. Nunn (2007) and Levchenko (2007) show that the quality of legal institutions can be a source of comparative advantage for countries since better contract enforcement can reduce the underinvestment of firms arising from the hold-up problem between contracting parties. Another strand of the empirical trade literature has emphasised that timeliness, i.e. the ability to export within short time delays, is an important determinant of trade (Hummels, 2001; Evans and Harrigan, 2005; Djankov et al., 2010).

In Chapter 3 we follow these studies and assess traditional and alternative sources of comparative advantage. The main contribution of the analysis is that it is the first study that thoroughly assesses comparative advantage patterns in trade separately for trade in intermediates and for trade in final consumption goods. In particular, we extend the existing findings by showing that the quality of institutions and the timeliness in exporting, i.e. the quality of transport infrastructure, provide a comparative advantage in exporting intermediate goods that are institutional-intensive or time-sensitive, respectively.

We use the BEC classification to break down trade flows into intermediate goods and consumption goods. We follow the empirical strategy of Nunn (2007) and assess the comparative advantage pattern of trade by looking at industry exports of countries to the world at the 6-digit level of the North American Industry Classification System (NAICS) in the year 2000. To test for comparative advantage, we interact industry variables with country variables. The coefficients of these interaction terms allow us to assess whether better institutions and better transport infrastructure increase relatively more exports in institutional-intensive and time-sensitive industries, respectively.

We indeed find that the quality of institutions and the quality of transport infrastructure are sources of comparative advantage for trade in intermediate goods. In particular, two results underline the importance of a country's ability to timely delivery for trade in intermediate goods. First, the quality of transport infrastructure is a more important factor in explaining the pattern of trade in intermediate goods than the quality of institutions. Second, while countries with a good transport infrastructure export relatively more time-sensitive intermediates and consumption goods, this comparative advantage pattern of trade is significantly stronger for intermediates. These findings have important policy implications as they suggest that investing in infrastructure and fostering trade facilitation would significantly boost a country's participation in production networks.

In Chapter 4 we assess trade in intermediate goods in the context of the activities of multinational enterprises by distinguishing between intra-firm trade in intermediates and arm's length trade in intermediates. We combine data from the U.S. Census Bureau on U.S. intra-firm imports in the year 2000 at the Harmonized System 6-digit (HS6) level with the BEC classification to identify intra-firm and arm's length trade in intermediate goods, capital goods and consumption goods. By providing a breakdown of trade flows according to the dimensions of use and ownership, this novel dataset allows a more nuanced analysis of trade of multinational enterprises in the context of international production networks. Table 1 gives a broad overview of the respective patterns of US imports. In 2000 trade in intermediates accounted for 47 percent of U.S. imports while intra-

firm transactions accounted for 48 percent. Hence, intra-firm trade and trade in intermediates are both significant in terms of volumes constituting almost 50 percent of U.S. imports each. The descriptive statistics furthermore reveal that the share of intra-firm imports in total imports is much higher for capital goods (59.4 percent) and intermediates (43.5 percent) than for consumption goods (19 percent). This discrepancy in the share of intra-firm trade, between intermediates and capital goods on the one hand and consumption goods on the other hand, provides a motivation for a distinct empirical analysis of intra-firm trade by type of good.

Table 1: Decomposition of U.S. imports in 2000 by ownership and main end use

Main end use (BEC classification)	Number of HS6 lines	Imports in Mill. USD	Total imports (%)	Intra-firm imports (%)	Arm's length imports (%)
Total	5,082	1,156,801.0	100.0%	47.5%	51.2%
Intermediate	3,153	545,316.3	47.1%	43.5%	53.9%
Consumption	1,235	244,898.6	21.2%	27.2%	72.7%
Capital	672	219,876.8	19.0%	59.4%	40.5%
Not classified	22	146,708.7	12.7%	78.9%	20.9%

Since most trade theories think of intra-firm trade as trade in intermediates, it seems essential also from a theoretical perspective to assess the determinants of intra-firm trade by type of good, especially distinguishing between intra-firm trade in intermediates and trade in final goods. Recent theoretical contributions (Grossman and Helpman, 2003; Antràs, 2003; Antràs and Helpman, 2004 and 2008) underscore the importance of incomplete contracts for the organisational decision of firms when sourcing a specialised intermediate input from a supplier. Following this literature, we explain the share of intra-firm trade in total trade by focusing on the hold-up problem as a main reason for the decision of firms whether to source intermediates from a foreign affiliate through intra-firm trade or from an independent supplier through arm's length trade. The hold-up problem refers to the exploitation of a contracting party by its counterparty because the contract is incomplete or not enforceable, while the investment undertaken is relationship-specific, i.e. worth less outside the relationship. We especially emphasise the role of contract enforcement as guaranteed by a country's legal institutions and the differences between intermediate inputs and final goods regarding the hold-up problem. Recent empirical papers such as Bernard et al (2010a and 2010b), Nunn and Trefler (2008) and Costinot et al. (2009) test predictions of these models. However, none of these papers distinguishes between intra-firm trade in intermediate goods and intra-firm trade in final goods except for Bernard et al. (2010b), who test the robustness of their main results by excluding final goods in regressions. Hence, by providing a systematic analysis of intra-firm trade in intermediates as compared to intra-firm trade in other good types, we are able to bridge the gap between empirical research and theoretical models on intra-firm trade.

We analyse the pattern of U.S. intra-firm imports at the HS6 level relying on country variables, product (industry) variables and the interaction of product (industry) and country characteristics. Our empirical estimation strategy follows closely Bernard et al. (2010a) in terms of variables used but also in terms of functional form, especially by considering both the extensive and the intensive margin of intra-firm trade.

We find that intra-firm trade at the HS6 product level is significantly higher for intermediates and capital goods as compared to consumption goods. In line with predictions from transaction cost models (Grossman and Helpman, 2003) and empirical findings (Bernard et al., 2010a), we find that better contract enforcement in a country reduces intra-firm trade relative to arm's length trade. According to the transaction cost approach, improvements in contract enforcement make the hold-up problem less severe so that the cost of outsourcing decreases relative to the cost of integration leading to a respective reduction in the share of intra-firm trade. Moreover, our results show that contract enforcement is more important for intermediates and capital goods relative to consumption goods at both the extensive and the intensive margin of intra-firm trade indicating that the hold-up problem is more important for intermediates and capital goods. A possible explanation for this result is that intermediates and capital goods require more relationship-specific investments of contracting parties as compared to consumption goods. Intermediates and capital goods are often tailored to the needs of the final good producer so that both the supplier and the final good producer might undertake substantial relationship-specific investment. A further reason for the higher share of intra-firm trade of capital and intermediate goods relative to consumption goods might be the context in which these goods are traded. While intermediate and capital goods are mainly traded between a final good producer and a supplier, much of the trade in final goods is taking place between the final good producer and a distributor, i.e. a retailer or a wholesale trader. The final good producer will tailor the good to the tastes of the consumer and the relationship with the distributor is not likely to require much relationship-specific investment. Hence, besides new analytical findings, this chapter also underlines the importance of being very precise when bringing theoretical models to empirical testing.

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1 The Determinants of GATS Commitment Coverage*

1.1 Introduction

The General Agreement on Trade in Services (GATS) launched in 1995 is considered to be the major outcome of the Uruguay Round. The agreement establishes a catalogue of rules and disciplines addressing commercial presence (such as foreign direct investment) in the service sector, trade in services, and even cross-border factor movements (such as the activity of expatriates). These rules and disciplines are targeted towards liberalising trade in services, thereby paralleling the objectives of the General Agreement on Trade and Tariffs (GATT) which were meant for goods trade only. The GATS introduces the following key concepts of rules and disciplines:

- ***Most favoured nation (MFN) clause*** ensures that member countries may not be selectively discriminated.
- ***Market access*** and ***national treatment*****:** In GATS, the following six market access restrictions are in principle prohibited: limitations on 1) the number of service suppliers allowed, 2) the value of transactions or assets, 3) the total quantity of service output, 4) the number of natural persons employed, 5) the type of legal entity allowed for the foreign service supplier, and 6) the participation of foreign capital in relative or absolute values. National treatment is a principle of non-discrimination and demands a treatment of foreign services suppliers which is no less favourable than that accorded to domestic providers.

While the MFN principle is a general rule, application of the market access and national treatment principles depends on each country's commitments:

- ***Horizontal commitments*** in terms of market access and national treatment apply to all sectors listed by a country as long as no sector-specific exceptions are made (see the next point).

* This chapter is joint work with Peter Egger, Department of Management, Technology and Economics (D-MTEC), Eidgenössische Technische Hochschule Zürich (ETHZ).

- ***Specific commitments*** are the country-and-sector-specific exceptions from the market access and national treatment principles. And for either of these principles the agreement distinguishes among four modes of supplying a service:
    - *Mode 1 – cross-border supply* (classical trade in services such as bank transfer or telephone calls)
    - *Mode 2 – consumption abroad* (e.g., tourism)
    - *Mode 3 – commercial presence;* (e.g., through foreign direct investment)
    - *Mode 4 – movement of natural persons* (e.g., the activity of expatriates)

While MFN follows a *negative list approach* (the MFN principle applies as long as no exemptions are notified to and applied under the auspices of the WTO), horizontal as well as specific commitments follow a 'conditional' *positive list approach*. The latter means that horizontal commitments are effective only for the sectors listed (and as long as no specific commitments/exemptions apply). Restrictions with regard to market access and/or national treatment become transparent only for the listed sectors. For unlisted sectors, countries are not bound in the type of restrictions implemented. Hence, the rules and principles under GATS bring about *conditional transparency* regarding restrictions of service transactions. Unconditional transparency about restrictions is not reached, because the restrictions for unlisted sectors may be more or less severe than those of the actually listed ones. Accordingly, a longer list of notified restrictions does not necessarily reflect a higher (maximum) level of impediments to service transactions. This is only true conditional on a sector's listing at all. In general, it is therefore unclear whether a longer list of sectors and partial commitments in GATS on average reflects an attitude towards liberalisation (through transparency) or towards protection (through restrictions). We assume that unlisted sectors are most restrictive.

It is this paper's purpose to study the economic fundamentals behind the coverage ratio of commitments (i.e., a country-specific weighted share of restrictions across sectors). In particular, we aim at understanding the deterministic part of this coverage ratio by means of econometric analysis against the background of general equilibrium work on trade and investment liberalisation. Given our theoretical motivation, we restrict our analysis to the determinants of commitments in commercial presence (Mode 3) and cross-border supply (Mode 1), since these two modes correspond most closely to foreign direct investment in services and "traditional" service trade, respectively. Among the four modes of supplying a service, commercial presence is clearly the most important one to the average GATS participant country. For instance, Hoekman (2006) reports that service sales by US foreign affiliates were around 50 per cent higher than US cross-border service exports in 2003. For the case of Tunisia, Konan and Maskus (2006) estimate

that 75 per cent of potential service liberalisation gains may be achieved through Mode 3 liberalisation.

Previous work on specific commitments in GATS has been either purely descriptive or focused on the financial sector. We aim at undertaking the first assessment of the economic fundamentals behind the extent of GATS commitments for trade and foreign direct investment in services across all service sectors. We put forward three sets of results: (i) large and rich (capital-abundant) economies tend to be more inclined towards liberalising service activities than small and poor ones, even though the latter group of economies should experience the larger welfare gains from doing so, according to economic theory. Explanations for this result might be found in the negotiation process and in poor domestic regulatory frameworks of service sectors in developing countries; (ii) 'experienced' liberalisers (namely, countries that were involved in free trade agreements prior to GATS) are more inclined towards liberalising services than other countries; and (iii) countries engage more likely in extensive service liberalisation through GATS, if their natural trading partners (neighbours) do so as well. The latter is an indication of herding behaviour in trade and investment liberalisation.

The structure of this paper is as follows. In the next section we shortly explain the extent of liberalisation under the GATS. In Section 1.3 we summarise insights from general equilibrium theory on trade and multinational enterprises with respect to the expected impact of liberalisation and provide hypotheses about the determinants of commitments. In the empirical part of the paper in Section 1.4 we provide a descriptive analysis of GATS commitments, formulate empirical specifications for estimation and report the associated results. The Section 1.5 concludes with a summary of the most important findings.

1.2 Trade and Investment Liberalisation under GATS?

While GATS introduces rules and disciplines on market access and national treatment related to service sector economic activity, it is not entirely clear how to think about its consequences in the context of trade and investment liberalisation. In principle, there are two channels through which the introduction of rules and disciplines could have had liberalising or quasi-liberalising effects on service trade and investment. One is the greater transparency of actually applied (or applicable) restrictions by country and sector from an investor's or exporting firm's point of view – greater transparency may be viewed as a quasi-reduction of barriers to trade and investment. A second possible channel is the reduction of restrictions in the course of their explicit formulation under GATS – a sort of race to the bottom caused by the requirement to make restrictions transparent.

While the role of GATS in creating greater transparency for exporters and multinational firms is uncontroversial, the accepted view about the second channel is that countries did not use commitments to a major extent for considerable liberalisation but mainly bound the status quo of their trade and investment regimes.[3] According to this view, GATS only quasi-liberalises trade and investment through greater transparency and legal security in the listed sectors at the country-level. However, the specific commitments in GATS reflect the restrictiveness of a country's trade and/or investment policy and, therefore, a country's general attitude towards liberalisation in these regards. Consequently, we may argue that countries which benefit most in welfare terms from trade and investment liberalisation should not only exhibit the lowest level of restrictions but also have a high incentive to make this fact transparent under GATS by notifying liberal commitments.

Regarding the (quasi-)liberalising nature of GATS, it is useful to recall the nature of commitments. First, GATS is a multilateral agreement where commitments are made unilaterally by countries. Hence, there is no discrimination between partner countries.[4] Accordingly, testable hypotheses about the determinants of GATS commitments (as quasi-liberalising standards for service trade and investment) can be gathered from the literature on the welfare effects of trade and investment liberalisation. This is the task of the subsequent section.

1.3 Theoretical Background

In order to provide predictions about the determinants of the GATS specific commitments, we rely on the general equilibrium theory of trade and multinational enterprises. In particular, guidance about a reduced-form relationship between economic fundamentals and the welfare effects of trade and/or investment liberalisation can be gathered from Markusen (2006), Markusen and Strand (2007) and Markusen, Rutherford and Tarr (2005), who explicitly address liberalisation in service trade. Insights from that line of research may be augmented by findings in Markusen (1997, 2002) and Egger, Larch, and Pfaffermayr (2007), who provide a welfare analysis of trade and investment liberalisation with a focus on goods transactions.

Markusen (2006) presents a set of general equilibrium models in order to investigate the welfare consequence of service offshoring with an industrialised (skilled labour-abundant) and a

[3] See Hoekman (1996) among others. A certain amount of liberalization was reached in the financial services and telecommunications sector as a result from after-1995 negotiations.

[4] However, since negotiations turned out to be difficult in the Uruguay Round, countries were allowed to list exemptions from the MFN principle in a further annex to GATS. These exemptions should have lasted not more than ten years in principle, i.e., no longer than until 2004. A second deviation from the MFN principle in GATS is allowed by preferential trade liberalization through Economic Integration Agreements between countries that have "substantial sectoral coverage".

developing (unskilled labour-abundant) country. The most comprehensive model he uses is a knowledge-capital model[5] of the multinational firm with three production factors (skilled and unskilled labour, know-how) and two goods (unskilled labour intensive Y, skilled labour intensive X). The production of good X can be fragmented into high-tech manufacturing M, which can be done only in the industrialised country and in middle-skill intensive services S, which might be offshored to the developing country. One of the crucial features of this model is that the firm specific know-how factor, which only the industrialised country is endowed with, is complementary with skilled labour in producing services S. Since the developing country lacks the complementary know-how factor, skilled labour is initially cheap there, although it is scarce. Liberalisation then implies that multinational firms move their firm-specific know-how to the developing country, where it works with cheaper skilled labour. While skilled labour will lose in North and gain in South, simulations predict that both countries might gain from liberalisation in welfare terms. However, while the developing country typically gains from fragmentation of service production, the skilled-labour abundant country may lose if it is too large. The reason for this potential welfare loss is an adverse terms-of-trade effect, which increases with the relative size of the industrialised country: if the industrialised country fragments X production by offshoring services and specialising in high-tech manufacturing, it loses its monopoly/market power and the price of X will fall.

Markusen and Strand (2007) build on Markusen (2006) and analyse the consequences of service trade and investment liberalisation policies in a two-final-good, two-factor, two-country general equilibrium model of trade and multinational enterprises. They put the emphasis of their analysis on the consequences of service trade/offshoring for industrialised countries and therefore solve the model for a world with a small, skilled labour-abundant and a large, unskilled-labour abundant country. Services are modelled as intermediates in the production of a final manufacturing good and might be fragmented in two ways. First, the production of services might be geographically separated from the final goods production, leading to cross-border trade in service inputs (Mode 1). Second, services themselves can be fragmented into an upstream headquarters activity and a downstream production activity, giving rise to foreign direct investment in services (Mode 3). Markusen and Strand (2007) compare welfare and equilibrium characteristics of four regimes (no trade and foreign investment allowed, only trade is feasible, only foreign investment is feasible and both trade and investment are allowed). In an extension they distinguish between two types of skilled labour: managers and routine skilled workers, with

[5] Markusen's knowledge-capital model is a framework where national, horizontal multinational and vertical multinational firms may arise endogenously in general equilibrium (Markusen, 2002). In that model, multinational firms employ skilled labour to create firm-specific assets which can be used in more than a single production facility without any extra costs.

the latter working in the downstream service activities which may be offshored. Simulation results indicate that trade liberalisation creates at least as large of a welfare gain for a small, skilled-labour abundant country as investment liberalisation does. While combined trade and investment liberalisation is equally desirable to trade or investment liberalisation alone in a two-factor model with skilled and unskilled labour, it brings the highest welfare gains in a three-factor model with two types of skilled workers. However, while managers gain much, routine skilled workers gain only few and the wage of unskilled labour is likely to fall.

Markusen, Rutherford, and Tarr (2005) consider a monopolistic competition model with producer services used as intermediate inputs. They do not formally distinguish between service trade and foreign direct investment. Two goods are produced by two factors, skilled labour and a composite factor. However, one good requires additionally a service input in production. This service input might be provided by domestic or foreign firms. While domestic firms use the two domestic factors in the production of this service, foreign firms additionally use a composite imported factor, whose price might be driven up by investment barriers. Liberalisation implies a fall in the cost of this imported factor. Markusen, Rutherford and Tarr (2005) conclude that trade and producer service investment liberalisation increase aggregate welfare in a developing country, but are particularly beneficial for skilled workers. Even though foreign services and domestic skilled labour are substitutes in partial equilibrium (we might say, in the short run), they are complements in general equilibrium (we might say, in the long run): foreign service providers substitute for domestic firms what then lowers demand for domestic skilled workers, since foreign service firms replace parts of the skilled labour with the imported foreign input. However, the resulting lower cost of service inputs leads to an expansion of the final good sector, which uses skilled labour intensively. This increase in demand for domestic skilled labour more than outweighs the reduction in demand from substitution of domestic service firms.

Previous and current research on trade and investment liberalisation in models with a focus on goods (rather than services) production comes to similar conclusions with respect to the welfare consequences of liberalisation. The findings in Markusen (2002) for a knowledge-capital model with goods production suggest that small countries almost always gain from investment liberalisation while large countries may lose. The reason is that small and (unskilled) labour abundant countries' inward investments react more sensitively to investment liberalisation than those in large and skilled labour (or capital) abundant ones. These results are confirmed also for unilateral investment liberalisation in Egger, Larch and Pfaffermayr (2007): small and/or capital-scarce countries gain more from unilateral investment liberalisation than large and/or capital-abundant ones.

Summarising the general equilibrium models mentioned above we can provide predictions about which countries should benefit most from trade and investment liberalisation in services and hence should have the highest coverage ratios in their commitments. Although the focus of our analysis is on commercial presence, we also look at the determinants of Mode 1 commitments, since the revisited literature often covers the effects of both trade and investment liberalisation. The role of country size and relative endowments tends to be similar for trade and investment liberalisation in the models mentioned above. Hence, predictions with respect to Modes 1 and 3 are the same.[6] Small countries typically gain more from trade and/or investment liberalisation, and therefore we expect that the coverage of Modes 1 and 3 commitments is higher for small countries. Hypotheses with respect to skilled-labour are less clear, since the literature promises welfare gains to both skilled labour-abundant countries (Markusen 2006, Markusen and Strand 2007) and developing countries (Markusen 2006, Markusen, Rutherford, and Tarr 2005) from trade and investment liberalisation in services. However, Markusen (2006) finds that a skilled labour-abundant country may lose if it is too large. Egger, Larch and Pfaffermayr (2007) come to a closely related result, namely that capital-scarce countries benefit more from investment liberalisation than from trade liberalisation. Their finding is especially relevant here since it considers welfare consequences from a country's unilateral investment liberalisation. Hence, skilled-labour scarce countries should be less restrictive in their GATS commitments for sectors listed. Since empirical evidence suggests that capital and skilled labour endowments are highly correlated, and data on capital is available for a larger number of countries, we put the emphasis on country size and capital-labour ratios in explaining the GATS commitments. However, we also run some specifications with measures of skilled-to-unskilled labour endowments instead of capital-labour ratios.

1.4 Empirical Analysis

1.4.1 Previous Studies

The first and most comprehensive evaluation of the specific commitments in the GATS has been done by Hoekman (1996). A more recent evaluation has been provided by Adlung and Roy (2005).[7] However, both Hoekman and Adlung and Roy provide only a descriptive analysis of the GATS specific commitments. Previous attempts to explain the determinants of GATS

[6] Also, the obligation to make a commitment for each mode of supply if a sector is listed, led to a similar extent of liberalization across modes.

[7] In contrast to Hoekman's work, their analysis covers more recent accession countries, more recent liberalizations from extended negotiations in the telecommunication and financial sector, as well as current offers from countries in the Doha Development Round.

commitments have been undertaken only for specific sectors. For instance, Harms, Mattoo and Schuhknecht (2003) explore the determinants of the GATS commitments in the financial sector of the agreement achieved in 1997.[8] They motivate most of their explanatory variables using a political economy model. Membership in a coalition group, unionisation, financial development and foreign presence are found to be the main determinants for liberal GATS commitments in the financial sector. Valckx (2004) extends the analysis of Harms, Mattoo and Schuhknecht with respect to the impact of commitments in the financial sector on financial crisis. He finds several macroeconomic variables to have some explanatory power for liberal commitments in the financial sector.

Contrary to Harms, Mattoo and Schuhknecht (2003) and Valckx (2004), we do not focus on a single sector but investigate the determinants of commitments in all sectors. Furthermore, we base our classification on the commitments made when the GATS came into force in 1995. For the sake of a sharper empirical design, we do not consider results from extended negotiations after 1995 in the financial services and the telecommunications sector. A final difference to previous work is that we treat EU member countries as separate entities, since they differ with regard to the type of listed commitments.[9]

1.4.2 Classification of Specific Commitments

Countries can make specific commitments for 155 service sectors. The listing of the commitments follows a positive-negative list approach: Countries are free to choose on how many service sectors they want to include in their national schedule of specific commitments. For unlisted sectors, countries are not bound in the type of restrictions implemented. However, if a country lists a sector, it must post commitments for each mode of supply and with respect to the market access and the national treatment principles. Hence, the market access and the national treatment principles set the boundaries to the breadth and depth of commitments. Countries are obliged to mention only restrictions and regulations within the scope of these two principles. When making a commitment, countries may choose among three broad types of commitments: none (full commitment), bound (partial commitment) and unbound (no commitment/full discretion).

An entry of 'none' implies that a country guarantees full market access/national treatment for a certain sector and mode of supply. The 'bound' category comprises all partial commitments, i.e., a country then guarantees market access/national treatment subject to the restrictions listed. If a

[8] Service negotiations continued in the financial sector after 1995 and were concluded in December 1997.
[9] Since EU countries have a joint schedule of commitments, they have the same number of listed sectors and commitments, respectively. However, individual EU member countries made different commitments in terms of liberality.

country chooses 'unbound', it does not commit to any market access/national treatment for a sector and mode.

In the classification of commitments under Mode 1, we follow Hoekman (1996) and assign the three commitment types none, bound and unbound values of 1, 0.5 and 0, respectively. These values reflect different degrees of restrictiveness. Commitments under Mode 3 are typically more extensive and more detailed than those under Mode 1. This reflects the predominant importance of commercial presence as mode of supply in service trade. Therefore, we use a more detailed restrictiveness index in order to classify commitments for Mode 3. For the identification of barriers to foreign direct investment in services we rely on Hardin and Holmes (1997) and subsequent work by Golub (2003). They distinguish three broad types of restrictions: foreign equity limits, screening and approval procedures, and other restrictions including mainly the movement of people and operational restrictions. However, in the construction and weighting of our index we follow more closely Harms, Mattoo, and Schuhknecht (2003). While the former two studies construct the restrictiveness index by cumulatively weighting all investment barriers a country has in place, we weight only the most restrictive measure of a single commitment, i.e., one commitment/one sector is assigned only one weight. We use this approach because we rely on GATS as our only source of information, while Hardin and Holmes (1997) and Golub (2003) use other sources, too. Furthermore, in GATS no other restrictions with respect to market access and national treatment than those mentioned are allowed. Hence, if a commitment in a certain sector is rather liberal, we can be sure about the restrictiveness of rules is in place. While Harms, Mattoo, and Schuhknecht (2003) focus on market access commitments, we combine market access and national treatment commitments in the calculation of our restrictiveness measure. In particular, for each listed sector the more restrictive commitment type, either market access or national treatment, is used in the calculation of the index. Overall, this obtains a balanced and fairly complete measure of a country's service liberalisation status which takes into account that the advantages of a free market access commitment in a sector can easily be offset by a quite restrictive national treatment commitment. Table 1.1 shows the classification scheme for the three commitment types (none, bound, and unbound, respectively). We used two slightly different, alternative weighting schemes for Mode 3 as summarised in the table. Since the obtained measures of liberalisation for Mode 3 are quite similar and the empirical results are insensitive to choosing variant 3i versus 3ii, we report subsequent results only for one scheme, namely 3i.

Table 1.1: Weighting scheme for commitments

Commitment	**Weight**		
	Mode 1	Mode 3i	Mode 3ii
SECTOR NOT LISTED	0	0	0
UNBOUND	0	0	0
BOUND:	0.5		
Foreign equity allowed			
Monopoly or No new entry		0.1	0.1
1-19%		0.35	0.4
20-34%		0.4	0.4
35-49%		0.45	0.4
50-74%		0.7	0.75
75-99%		0.75	0.75
Screening and approval			
Investor must show economic benefits		0.25	0.25
Economic needs test		0.25	0.25
Discretionary licensing		0.25	0.25
Licensing/approval/authorization required		0.35	0.4
Other restrictions			
Majority of managers/board of directors must be national or resident		0.5	0.5
Citizenship requirement		0.5	0.5
At least 1 (1/3) of managers/board of directors must be national or resident		0.65	0.65
Residency requirement - living at least 3 (1) years in the country		0.65	0.65
Requirement w.r.t. legal form		0.75	0.75
Act/Law which applies		0.75	0.75
Notification/Registration requirement		0.75	0.75
Other minor restrictions		0.75	0.75
NONE	1	1	1

If only an aggregated sector is listed, we assume that commitments apply to all sub-sectors. Similarly, if only a part of a service sector is included, we typically use the corresponding weight for the entire sector. Furthermore, we assume that no information/no commitment is more restrictive than any information/commitment, no matter which one. Hence, if a sector is not listed it is attributed a value of zero in our quantitative measure of liberalisation. Also an entry of unbound, indicating that the country keeps full policy discretion, is counted as zero in the calculation of the liberalisation index. Contrary to Hardin and Holmes (1997) and Golub (2003), but following Harms, Mattoo, and Schuknecht (2003) we assume that restrictions regarding the approval of investment are more/at least as restrictive as foreign equity limits.

We construct our liberalisation measure as a weighted coverage ratio:

$$WCov_{mi} = \frac{\sum_{j=1}^{S} weighted\,count_{mi}}{S} \qquad \text{for } m = 1,3; \quad i = 1,\ldots,N; \quad j = 1,\ldots,S$$

where m, i, and j, are indices for mode, country, and sector. The weighted coverage ratio $WCov_{mi}$ for country *i* is the weighted count of posted commitments of Mode *m* divided by the number of sectors the country could eventually list (S=155). Since the most liberal commitment possible ('none') is assigned a value of one, the number of all sectors S – listed and unlisted – corresponds to free service trade. Hence, our coverage ratio indicates the share/extent of liberalisation, i.e., it is the weighted share of service sectors a country has been willing to liberalise. The weighted coverage ratio is driven by two factors, the number and the liberality of commitments made. If a country listed only few sectors, its weighted coverage ratio will be small, since the numerator of $WCov_{mi}$ declines while *S* remains unaffected. Hence, for the interpretation of $WCov_{mi}$ as a measure of a country's service liberalisation, it is crucial that non-listed sectors are less liberalised.[10]

1.4.3 Features of the Coverage Ratios

In summarising the commitments we group countries into low, middle and high income countries according to the World Bank classification for 1995. 25 countries are classified as low income, 47 countries as middle income and 34 countries as high income. The detailed country composition of the three groups and the weighted coverage ratio for Mode 3 is shown in Table 1.9 in Appendix 1.A.[11] Table 1.2 reports summary statistics of commitments in Mode 1 and 3 for the three country groups.

[10] We checked for the sensitivity of this assumption by using the number of all sectors a country listed any commitments in instead of S=155 in the denominator of $WCov_{mi}$. However, then, both the number of countries covered and the explanatory power of the model in terms of R^2 drops substantially.

[11] We include the same countries as Hoekman (1996) plus the 12 EU countries in our analysis. Thus, also countries which scheduled commitments by mid 1994 but became member of the WTO at a later point in time are included, i.e., China (2001), Congo (1997), but not Algeria (not member yet).

Table 1.2: Averages for specific commitments indicators by country income group as of 1995

	Mode 1				***Mode 3***			
	Income group							
Statistic	All	Low	Middle	High	All	Low	Middle	High
Countries	106	25	47	34	106	25	47	34
Number of commitments	42.0	15.4	31.7	76.0	42.0	15.4	31.7	76.0
Coverage ratio	27.1	9.9	20.4	49.0	27.1	9.9	20.4	49.0
Weighted coverage ratio (*WCov*)	19.2	5.6	12.2	38.7	20.1	6.1	12.4	41.1
WCov, without financial and telecomm. services	19.1	4.5	12.3	39.3	20.8	4.7	12.8	43.5
WCov, only business services	24.2	2.9	14.9	52.7	27.4	4.7	16.5	59.2

Notes:
Income groups according to World Bank 1995: Low, Middle, High. Source:
http://siteresources.worldbank.org/DATASTATISTICS/Resources/OGHIST.xls
Coverage ratio of posted commitments relative to number of possible commitments.
Weighted coverage ratio of weighted commitments made to number of possible commitments.
For *WCov*, weights as in Table 1 are used. For Mode 3, we use scheme 3i in Table 1.

On average, countries listed only 42 out of 155 sectors. This corresponds to a coverage ratio of only 27.1 percent.[12] Richer countries listed more commitments on average. While the average income country has a coverage of 49 percent, middle and low income countries have one of 20.4 and 9.9 percent, respectively, across all sectors.

For the calculation of the weighted coverage ratios (*WCov*), weights of Table 1.1 reflecting different degrees of restrictiveness are used. Since the weighting schemes differ between Mode 1 and Mode 3, the weighted coverage ratio can only be compared across different sector groups but not across modes. Furthermore, the weighted coverage ratio must be equal to or lower than the normal coverage ratio. It would be the same if all sectors listed by a country were fully liberalised (none). Similar to the simple (un-weighted) coverage ratio, the weighted coverage ratio is on average higher for rich countries. For Mode 3 and all sectors, high income countries exhibit a weighted coverage ratio of 41.1 percent compared to ones of 12.4 and 6.1 percent for the middle and low income countries.

Furthermore, we calculated the weighted coverage for two subsets of the 155 sectors. First, we excluded the financial and the telecommunications services from the coverage, because negotiations continued until 1997 in these two groups of sectors. Second, we calculated the weighted coverages for 46 business sectors only. While the weighted coverage ratio remains basically unchanged for the first group, for business services it is even higher for middle and high income countries relative to low income countries than with the benchmark measures.

[12] The number of commitments does not vary across modes since countries must make a commitment for every mode if a sector is listed. Hence, the number of commitments for a mode corresponds to the number of sectors listed by a country.

1.4.4 Specification

In the light of the theoretical hypotheses summarised in Section 1.2, we may specify the weighted coverage ratio of GATS commitments announced in 1995 under Modes 1 or 3 in the following way:[13]

$$\ln\left(\frac{WCov_{m,i}}{1-WCov_{m,i}}\right)=\alpha_{m,0}+\sum_{k=1}^{K}\alpha_{m,k}X_{k;i}+u_{m,i}\quad for\quad m=1,3;\quad i=1,...,N, \tag{1}$$

Notice that the left-hand-side appears in a logistically transformed way to ensure that the predictions of the model will fall in the possible support region for *WCov*. $X_{k,i}$ is the *k*th of *K* explanatory variables in the model, $\alpha_{m,0}$ is a mode-specific constant, $\alpha_{m,k}$ are unknown parameters, and $u_{m,i}$ is a stochastic error term.

Section 1.2 suggests using (the log of) country size and (the log of) capital-labour ratios endowments as two determinants (among the X_k) of trade and/or investment liberalisation. Furthermore, we include two variables indicating the extent of trade liberalisation prior to GATS membership in terms of the fraction of partner countries trade is liberalised via a customs union or free trade area (FTA) or via another preferential trade agreement (PTA). We expect these variables to be positively related to the GATS coverage rates coverage since countries inclined towards goods trade (and partly also service) liberalisation at the bilateral level in the past should more likely be willing to also liberalise trade in services unilaterally. This argument is indirectly supported by Ornelas (2005). In a somewhat different context, he shows that (goods trade) regionalism through FTA membership is a building block to multilateral trade liberalisation, which is intended by the GATS. Additionally, we use dumping and antidumping measures, capturing barriers to goods trade, as additional controls. On the one hand, we employ information about the number of anti-dumping cases a country had filed against other economies prior to 1990. On the other hand, we use the number of cases other economies had filed against this country. Similar to the previous arguments about FTAs and PTAs, these two variables should be related to a country's active use of trade policy.

Summary statistics of explanatory variables are shown in Table 1.3. We use the log of real GDP in US dollars for the year 1993 (from the World Bank's World Development Indicators) as a measure of country size to explain the coverage ratios announced in year 1995. Furthermore, we include the log of capital per capita ratios in 1993 estimated by the perpetual inventory method as

[13] We use a logistic transformation of the coverage ratio on the left-hand side to make sure that the model predictions will lie in the interval [0, 1].

a proxy for capital labour ratios. To construct capital stocks, we use data on gross fixed capital formation from the World Development Indicators.[14] Information about FTA and PTA is taken from the WTO. Note that in our unilateral context these variables measure the fraction of countries a particular economy had bilaterally liberalised trade with prior to 1990. Data on antidumping are taken from Egger and Nelson (2007).[15]

Table 1.3: Summary statistics for explanatory variables used in regressions

Variable	Obs	Mean	Std. Dev.	Min	Max
Log real GDP (1993)	87	24.084	2.280	19.280	29.642
Log capital per capita (1993)	87	8.273	1.593	5.116	11.014
Higher School attained (%)	77	0.092	0.087	0.001	0.463
FTA (free trade area membership)	87	0.015	0.029	0.000	0.080
PTA (preferential trade agreement membership)	87	0.017	0.029	0.000	0.087
AD (anti-dumping cases filed; active)	87	51.345	124.908	0.000	704.000
AD* (anti-dumping cases filed; passive)	87	46.483	91.643	0.000	594.000

Notes:
Higher School attained (%) is the percentage of "higher school attained" in the total population in 1990.
FTA is the fraction of countries an economy was engaged with in free trade agreements notified to the WTO between 1970 and 1990.
PTA is the fraction of countries an economy was engaged with in free trade agreements notified to the WTO between 1970 and 1990.
AD is the number of cases filed by a country against others since 1970 up to 1990.
*AD** is the number of antidumping cases filed against a country by others since 1970 up to 1990.

1.4.5 Regression Results

Table 1.4 presents regression results using the logistically transformed coverage ratio for all sectors of Modes 1 and 3 as the dependent variable and different sets of explanatory variables. We start with a basic regression (1) using only size and the capital-labour ratio on the right-hand-side. The results can be summarised as follows.[16]

[14] An annual depreciation rate of 13.3 percent is assumed throughout. Notice that starting years of the investment data vary for the benchmark results. However, we ran alternative regressions where we used capital stock data which were based on investment data from 1990-1993 only. It turns out that the results are insensitive to that modification.
[15] We measure the use of *dumping measures* of country *i* as the total number of antidumping cases filed against country *i* by others since 1970 up to 1990. In contrast, the number of *antidumping measures* used by country *i* is the number of cases filed by country *i* against others since 1970 up to 1990. We do not consider cases later than 1990 to avoid any feedback effects from GATS on the use of dumping and antidumping measures.
[16] One to maximal four countries are lost with the logistic transformation, because their coverage ratios equals the lower bound 0.

Table 1.4: Regression results for the determinants of weighted GATS commitment coverage of all sectors services

	Mode 1					***Mode 3***				
Explanatory variables	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*
Log GDP (1993)	0.220 ***	0.139 **	0.204 ***	0.108	0.196 *	0.321 ***	0.267 ***	0.302 ***	0.291 ***	0.338 ***
	(0.049)	(0.062)	(0.067)	(0.100)	(0.108)	(0.044)	(0.055)	(0.059)	(0.103)	(0.111)
Log capital per capita (1993)	0.581 ***	0.402 ***	0.392 ***			0.498 ***	0.336 ***	0.341 ***		
	(0.080)	(0.101)	(0.101)			(0.079)	(0.094)	(0.094)		
Higher school attained (%)				5.007 ***	5.844 ***				4.405 ***	5.829 ***
				(1.334)	(1.491)				(1.271)	(1.463)
FTA		14.668 ***	10.288 **	29.564 ***	20.883 ***		15.532 ***	10.250 **	26.534 ***	17.261 ***
		(3.908)	(5.165)	(3.270)	(4.784)		(3.569)	(4.694)	(3.498)	(4.762)
PTA			-9.231 **		-10.628 **			-4.476		-7.097
			(4.629)		(5.117)			(3.907)		(4.342)
AD		0.001	0.000	0.000	-0.002 **		0.000	-0.001	-0.001	-0.004 ***
		(0.001)	(0.001)	(0.001)	(0.001)		(0.001)	(0.001)	(0.001)	(0.001)
AD*		0.001	0.001	0.003 **	0.002		0.001	0.001	0.002	0.001
		(0.001)	(0.002)	(0.001)	(0.002)		(0.001)	(0.001)	(0.001)	(0.002)
EU			0.200		0.707 *			0.578 **		1.150 ***
			(0.262)		(0.376)			(0.232)		(0.339)
Constant	-11.980 ***	-8.847 ***	-10.074 ***	-5.562 **	-7.381 ***	-13.690 ***	-11.343 ***	-12.089 ***	-9.730 ***	-10.746 ***
	(1.073)	(1.687)	(1.803)	(2.306)	(2.465)	(1.006)	(1.479)	(1.600)	(2.429)	(2.610)
Countries	86	84	84	75	75	89	87	87	77	77
R^2	0.603	0.642	0.664	0.618	0.650	0.646	0.687	0.696	0.643	0.668

Notes: Robust standard errors in parentheses. ***significant at 1%; ** at 5%; * at 10%. The dependent variable is the weighted coverage ratio of the respective mode.

The explanatory power of the model based on two explanatory variables only is remarkable. The R^2 is 0.603 and 0.646 for Modes 1 and 3, respectively. For the less parsimonious models (2)-(5), the R^2 takes values between 0.6 and 0.7. Both country size and capital per capita have a positive coefficient which is significant at the 1 percent level in (1). In (2) and (3), we add the aforementioned trade friction/liberalisation indicators as well as dummy variable, indicating whether an economy was a member of the EU prior to 1996 or not.[17] Results regarding country size and capital per capita are confirmed to be robust in these less parsimonious specifications: large and capital abundant countries are more liberal in terms of the weighted coverage for both Modes 1 and 3. The variable *FTA*, indicating the average fraction of partner countries in free trade agreements between 1970 and 1990, has a significant positive impact on the weighted coverage ratio for both Modes 1 and 3. The coefficient of *FTA* is significantly different from zero at 1 per cent in (2) and at 5 per cent in (3), respectively. On the contrary, *PTA* membership (which represents a less effective form of trade regionalism than *FTA* membership) is associated with less effective service liberalisation. This negative effect is significant at the 5 percent level in equation (3) for Mode 1 but it is insignificant for Mode 3. The coefficients of the antidumping variables *AD* and *AD** are not significantly different from zero, neither in equation (2) not in (3). In regression (3) we also included the aforementioned dummy for EU membership, which is significantly positive at 5 percent for Mode 3.

Since the theoretical models we rely upon mostly employ skilled-to-unskilled labour ratios rather than capital-labour ratios, we employ a specification based on a measure thereof instead of capital-labour ratios. In equations (4) and (5) of Table 1.4, we use the higher school attainment ratio from the Barro-Lee dataset on Educational Attainment (2001) as a measure of skilled labour abundance instead of capital abundance. Note that in all other regards regressions (4) and (5) are the same as (2) and (3). Not surprisingly, the schooling variable takes as a positive coefficient and is significant at 1 per cent in (4) and (5) for both modes, similar to the capital-labour ratio in models (2) and (3). Also the results for the other explanatory variables remain fairly stable. While real GDP is still significant for Mode 3, it becomes insignificant in (4) and is significant only at 10 percent in (5) for Mode 1. However, it should be mentioned that using the skilled-to-unskilled labour ratio rather than the capital-labour ratio involves a fairly sizable loss of observations so that we should be careful with comparing the results.

Overall, the results regarding the impact of relative factor endowments are somewhat surprising from a theoretical perspective. Theory predicts that small and poor (unskilled labour abundant or labour abundant) economies should obtain the largest gains from liberalisation. Yet, empirical

[17] Since the number of commitments is the same for all EU countries, the weighted coverage ratios differ because of different degrees of restrictiveness in each country's commitments.

results indicate that these countries are less inclined towards liberalisation of services trade and investment than others. Possible explanations may be found in the design of the negotiation process[18] and in regulatory concerns about service sectors. Large countries can more easily make concessions to negotiating partners than small countries in order to obtain a desired commitment. Hence, the commitment coverage of large countries may be broader than that of small countries, because they are able to outweigh domestic protectionist pressure with access gains more easily than small economies.

Hoekman and Mattoo (2007) mention asymmetric export interests and domestic regulatory concerns as two reasons for limited liberalisation in GATS: industrialised and developing countries differ in their export interests relative to the mode of supply. While industrialised economies mainly seek market access for their multinational enterprises, i.e., liberalisation under Mode 3, they oppose liberalisation under Mode 4, the temporary movement of people. Overall, interests in liberalisation of services on the part of industrialised countries are very different from those of developing countries. Accordingly, the missing reciprocity of interests in liberalising service transactions at least within different modes under GATS may explain the low commitment coverage of developing countries as compared to GATT. Other explanations relate to the fact that poor countries often lack comprehensive domestic regulation in service sectors. They might decide to not make a commitment because (i) without functioning domestic regulations potential benefits from liberalisation may not be realised, (ii) domestic regulators might be afraid that commitments in GATS prohibit the introduction of new welfare-improving regulations in the future, and (iii) countries are not allowed to introduce new restrictions after a GATS commitment is made.

1.4.6 Extensions

1.4.6.1 Results for Subsets of Sectors

[18] Negotiations in services take the form of a request–offer approach. Thereby, requests are typically made bilaterally in the form of letters between countries. Then, offers are published multilaterally in the form of a schedule of commitments. After analysing the offers of other economies, a country will start again with posting bilateral requests. The process ends when countries jointly accept the whole schedule of commitments. GATS builds on the principle of joint acceptance of member countries. In contrast, the negotiation process for GATT is a more bilateral approach and also evolved over time: bilateral concessions in GATT, for example, tariff cuts, are subsequently automatically 'multilateralised' by the MFN principle.

In Table 1.5 and Table 1.6 we report results using the weighted coverages of a subset of sectors as the dependent variable. Results are reported for the two least parsimonious models for either mode, i.e., specifications (3) and (5) as in Table 1.4, respectively. In Table 1.5 the weighted coverage excludes the financial and the telecommunications sectors.[19]

Table 1.5: Determinants of weighted commitment coverage excluding financial and telecomm. services

	Mode 1				***Mode 3***			
Explanatory variables	*(3)*		*(5)*		*(3)*		*(5)*	
Log GDP (1993)	0.211	***	0.215	*	0.329	***	0.362	***
	(0.071)		(0.117)		(0.064)		(0.114)	
Log capital per capita (1993)	0.413	***			0.332	***		
	(0.103)				(0.100)			
Higher school attained (%)			5.629	***			6.261	***
			(1.508)				(1.473)	
FTA	12.226	**	22.482	***	13.455	**	18.834	***
	(5.726)		(5.407)		(5.286)		(5.207)	
PTA	-9.493	**	-11.938	**	-6.252		-9.869	**
	(4.694)		(5.288)		(4.245)		(4.542)	
AD	0.000		-0.003	***	-0.001		-0.004	***
	(0.001)		(0.001)		(0.001)		(0.001)	
AD*	0.002		0.003	*	0.001		0.001	
	(0.002)		(0.002)		(0.001)		(0.002)	
EU	0.176		0.637		0.532	*	1.193	***
	(0.274)		(0.383)		(0.275)		(0.370)	
Constant	-10.496	***	-7.838	***	-12.692	***	-11.296	***
	(1.777)		(2.646)		(1.620)		(2.643)	
Countries	82		72		86		75	
R^2	0.695		0.686		0.720		0.711	

Notes:
Robust standard errors in parentheses. ***significant at 1%; ** at 5%; * at 10%. The dependent variable is the weighted coverage ratio of the respective mode.

The previous results are confirmed for the chosen sub-sectors with regard to the main variables of interest. The signs of coefficients and the significance levels remain identical for real GDP, capital per capita, and the schooling variable. While the coefficients do not change sign for any variable, the significance level of variables indicating previous trade liberalisation/distortions changes slightly to the better. Only the impact of EU membership is less significant than before in specification (5) for Mode 1 and specification (3) for Mode 3.

In Table 1.6 we use the weighted coverage of 46 business services as the dependent variable. Since many countries have not included any business service sector in their list of commitments

[19] The reason is that the GATS participants as of 1995 decided to continue with negotiations with respect to liberalization in financial and telecommunication services, and an agreement was reached only in 1997.

or those included business sectors are unbound, we would lose on average 25 observations for Mode 1 and 18 observations for Mode 3. Hence, we chose different boundary values for the logarithmic transformation of the weighted coverage of business services.[20]

Table 1.6: Determinants of weighted GATS commitment coverage for business services

	Mode 1		***Mode 3***	
Explanatory variables	*(3)*	*(5)*	*(3)*	*(5)*
Log GDP (1993)	0.397 **	0.325	0.692 ***	0.765 ***
	(0.182)	(0.266)	(0.141)	(0.211)
Log capital per capita (1993)	0.747 ***		0.712 ***	
	(0.234)		(0.157)	
Higher school attained (%)		12.062 ***		10.055 ***
		(3.333)		(2.864)
FTA	27.721 **	44.601 ***	10.930	26.623 ***
	(12.796)	(10.308)	(8.477)	(9.411)
PTA	-15.114	-21.192 *	-14.224	-19.484 **
	(11.170)	(12.006)	(8.799)	(9.500)
AD	0.000	-0.005 **	-0.003 ***	-0.008 ***
	(0.002)	(0.002)	(0.001)	(0.002)
AD*	0.002	0.004	-0.001	0.001
	(0.004)	(0.004)	(0.003)	(0.004)
EU	-0.133	1.006	0.954 *	1.801 **
	(0.559)	(0.752)	(0.497)	(0.712)
Constant	-18.778 ***	-12.072 **	-24.532 ***	-21.472 ***
	(4.307)	(5.952)	(3.209)	(4.889)
Countries	88	78	88	78
R^2	0.562	0.547	0.672	0.627

Notes:
Robust standard errors in parentheses. ***significant at 1%; ** at 5%; * at 10%. The dependent variable is the weighted coverage ratio of the respective mode.

Results for the determinants of the weighted coverage of business services in Table 1.6 mainly confirm our previous findings, with the exception that real GDP is not significant anymore in specification *(5)* for Mode 1. It is notable that the variable indicating the number of filed antidumping cases between 1970 and 1990 (*AD*) enters negatively and is highly significant in both models for Mode 3 and in one model for Mode 1.

1.4.6.2 Political Determinants of Commitments

Besides the general equilibrium models of trade and multinational enterprises other strands of economic theory may be useful to explain GATS commitments. For instance, political economy models of trade policy illustrate how interest groups try to influence politicians to influence trade

[20] Following Wooldridge (2002), we use the transformation TWCov = (WCov + 0.001)/(1 + 0.001), where the WCov lies between 0 and 1. Then, the standard logarithmic transformation as in (1) isapplied to TWCov.

policy (participation in FTAs or tariff setting) in their favour (for instance, see Grossman and Helpman, 1995). In particular, that literature shows how opposing interests in and the relative strength of export an import competing sectors play an important role for the outcome of negotiations.

While the required sector-level data are not available for a large cross-section of economies as ours, we may still infer the influence of variables that are likely reflective of the importance of interest groups at the aggregate level. These variables are gathered from two sources, the Polity IV Project (Marshall and Jaggers, 2002) and a dataset on comparative economics from the World Bank (Beck, Clarke, Groffe, Keefer, and Walsh, 2001). The political economy literature suggests a set of different variables to be indicative of lobbying activities.

Biglaiser and Brown (2001) argue that lobbying is more difficult, if a country's legislature is very fractionalised. We would then expect countries with a more fractionalised political systems (captured by a variable which we will refer to as *Frac*) should have a higher weighted coverage ratio. Persson (1998) argues that a higher quality of a country's checks and balances (captured by a variable *Checks*) should hinder lobbying efforts. Another factor which might constrain the effectiveness of lobbying is the degree of polarisation in the political system (*Polariz*). The more parties are polarised the more they suffer from not being in government and by not having their preferred policy implemented. Therefore, the effectiveness of interest groups is suspected to decline in party polarisation (Testa 2003). Biglaiser and Brown (2001) provide evidence that polarised legislatures render an agreement on policy reforms more difficult to achieve. Furthermore, we use a durability indicator (*Durable*) reflecting the number of years since the last greater regime change had happened and a variable indicating the number of years the chief executive has been in office (*Yrsoffc*). The political economy literature suggests that a regime change fosters the formation of political institutions and the implementation of reforms.

Furthermore, we test the results put forward by Harms, Mattoo, and Schuknecht (2003), namely that a country's affiliation with a coalition group influences the coverage ratio of commitments. For this, we include a dummy variable indicating the membership in the Cairns group of agricultural exporting nations (apart from the dummy variable capturing EU membership).[21]

In Table 1.7 we present results for both Mode 1 and 3 (i.e., cross-border trade and commercial presence), estimating four specifications. Specifications (1) and (2) use capital per capita and extend the most as well as the least parsimonious models estimated before by the aforementioned

[21] Cairns Group: Argentina, Australia, Brazil, Canada, Chile, Colombia, Indonesia, Malaysia, Paraguay, Peru, Philippines, South Africa, New Zealand, Thailand, Uruguay. Not included due to after-1995 joining: Bolivia, Costa Rica, Guatemala, Pakistan.

political variables. Models (3) and (4) do the same but with the skilled labour variable used instead of the capital-labour ratio. Unfortunately, the use of data on political variables leads to a loss of observations so that the sample size now only ranges from 62 to 68 observations, depending on the specification. Surprisingly, almost all political variables are insignificant for all estimated models. Only the variable indicating the quality of checks and balances of the political system is significant at 10 percent in model (1) for either mode.

Table 1.7: Extended regression results including political variables

	Mode 1				***Mode 3***			
Explanatory variables	*(1)*	*(2)*	*(3)*	*(4)*	*(1)*	*(2)*	*(3)*	*(4)*
Log GDP (1993)	0.100	0.078	0.254 ***	0.129	0.241 ***	0.206 **	0.363 ***	0.273 **
	(0.062)	(0.082)	(0.093)	(0.128)	(0.067)	(0.083)	(0.083)	(0.109)
Log capital per capita (1993)	0.698 ***	0.581 ***			0.520 ***	0.373 ***		
	(0.114)	(0.128)			(0.128)	(0.129)		
Higher school attained (%)			5.228 *	10.004 ***			3.176	7.599 ***
			(2.619)	(2.593)			(2.295)	(2.059)
FTA		9.694		26.654 ***		12.507		23.010 ***
		(7.847)		(7.795)		(8.294)		(8.247)
PTA		-8.924 *		-9.073		-7.375 *		-9.503 **
		(5.248)		(5.575)		(3.955)		(4.036)
AD		0.001		-0.002 **		0.000		-0.002 **
		(0.001)		(0.001)		(0.001)		(0.001)
AD*		0.001		0.002		0.001		0.001
		(0.002)		(0.002)		(0.001)		(0.001)
EU		0.021		0.630		0.370		0.717 **
		(0.378)		(0.426)		(0.438)		(0.405)
Checks	0.217 *	0.151	0.124	0.069	0.146 *	0.087	0.047	-0.005
	(0.114)	(0.127)	(0.130)	(0.125)	(0.084)	(0.104)	(0.095)	(0.090)
Polariz	-0.097	-0.111	0.169	-0.094	0.004	-0.060	0.204	-0.019
	(0.192)	(0.218)	(0.234)	(0.206)	(0.145)	(0.151)	(0.191)	(0.128)
Frac	-0.683	-0.433	0.238	0.093	0.468	0.656	1.295	1.079
	(0.819)	(0.800)	(0.876)	(0.886)	(0.792)	(0.825)	(0.833)	(0.818)
Durable	0.000	-0.007	0.004	-0.013	0.000	-0.006	0.002	-0.015
	(0.005)	(0.007)	(0.007)	(0.008)	(0.006)	(0.008)	(0.008)	(0.009)
Yrsoffc	0.021	0.011	0.029	0.029	0.013	0.002	0.011	0.004
	(0.018)	(0.017)	(0.027)	(0.026)	(0.019)	(0.020)	(0.023)	(0.023)
Cairns	-0.296	0.151	-0.776 *	-0.214	0.029	0.570 *	-0.346	0.190
	(0.301)	(0.444)	(0.432)	(0.475)	(0.207)	(0.319)	(0.293)	(0.263)
Constant	-10.371 ***	-8.664 ***	-9.254 ***	-6.069 **	-12.745 ***	-10.600 ***	-11.909 ***	-9.457 ***
	(1.421)	(2.256)	(2.111)	(2.808)	(1.676)	(2.185)	(1.989)	(2.413)
Countries	68	67	62	62	68	67	62	62
R^2	0.682	0.723	0.518	0.705	0.700	0.754	0.593	0.757

Notes: Robust standard errors in parenthesis; ***significant at 1%; ** at 5%; * at 10%. The dependent variable is the weighted coverage ratio of the respective mode. Variables FTA, PTA, AD, and AD* are averages for the period 1970-1990. Values of all other variables are for 1993.

The dummy indicating the membership in the agricultural coalition *(Cairns)* is significant at 10 percent level in two models. However, the sign of the coefficient is unstable. In model (3) for Mode 1, the coefficient of *Cairns* is negative, while it is positive in model (2) for Mode 3. Results for the other variables turn out to be quite stable. The capital per capita variable exerts a significant positive influence on the weighted coverage ratio in all models for either mode. Real GDP is positive and significant in all specifications for Mode 3, but insignificant in three out of four specifications for Mode 1.

Overall, the results bear a clear message: once country size and factor endowments (capital-labour ratio, skilled-unskilled-labour ratio) are controlled for, it is hard to identify any robust and significant impact of political variables on the weighted coverage of commitments.

1.4.6.3 Cross-country interdependence in listing specific commitments

One basic assumption the previous results rely upon is that countries act fully independently of each other in their listing of GATS commitments. However, this assumption is likely to be inadequate. Since GATS is based on multilateral negotiations, countries will condition their commitments on those made by other countries. Whose example will they follow and whose liberalisation strategies will they condition their own upon? We hypothesise that a country will commit to more liberal policies if other economies that are highly relevant to the country of interest will do so as well. As for the latter, we hypothesise that geographical neighbours will adopt a similar extent of liberalisation through GATS commitments.

In order to take account of this interdependence between economies we extend our analysis by using spatial econometric methods. In particular, we aim at conditioning on a country's neighbours' weighted coverage ratio for its own commitment ratio. For each country in the sample, we do so by calculating the inverse-distance weighted average of the coverage ratios of all other economies. Let us denote the $n \times 1$ vector of logistically transformed, weighted coverage ratios of all economies by y. Then, we may write the 'spatial' counterpart of equation (1) in vector form as:

$$y_m = \lambda_{m,0} W y_m + \alpha_{m,0} + \sum_{k=1}^{K} \alpha_{m,k} X_k + u_{m,} \quad \text{for} \quad m = 1,3, \qquad (2)$$

Where W is an $n \times n$ matrix of normalised inverse-distance weights, with n denoting the number of observations.[22] For convenience, we normalise all entries in a particular row of that matrix by the sum of all entries in the same row. One of the necessary assumptions the is that $|\lambda_{m,0}| < 1$. Furthermore, we allow for interdependence among the disturbances by assuming $u_m = \rho_{m,0} M u_m + \varepsilon_m$, where M is an $n \times n$ weights matrix similar to W.[23]

[22] The importance of distance for trade connectivity is supported theoretically and empirically by the gravity model (see among others Anderson and Wincoop 2003). Furthermore, Baier and Bergstrand (2004) determine natural trading partners by the value of inverse distance between two countries The elements of W, w_{ij}, are computed as $w_{ij} = e^{-\delta_{iij}}$, where δ_{ij} is the scaled distance between the most important cities (in terms of population) of two countries. Hence, a higher level of distance of a partner country assigns a smaller weight to this country's weighted coverage ratio.

[23] With a row-normalized M, $|\rho_{m,0}| < 1$, similar to $\lambda_{m,0}$.

The matrices W and M reflect different degrees of interdependence among economies in their listing of commitments. Wy_m is a vector of weighted averages in the other countries' weighted coverage ratios, and Mu_m captures interdependence regarding the stochastic part of the weighted coverage ratios. The parameters λ_0 and ρ_0 indicate the relative importance of interdependence. The reduced-form version of (2) then reads:

$$\begin{aligned} y_m &= \left(I - \lambda_{m,0} W\right)^{-1} \left(\alpha_{m,0} + \sum_{k=1}^{K} \alpha_{m,k} X_k + u_{m,} \right) \\ u_m &= \left(I - \rho_{m,0} M\right)^{-1} \varepsilon_m \end{aligned} \tag{3}$$

The variance-covariance matrix (VC) of u_m is

$$E\left[u_m u_m'\right] = \Omega_{m,u} = \sigma^2_{m,\varepsilon} (\mathrm{I} - \rho_{m,0} M)^{-1} (\mathrm{I} - \rho_{m,0} M')^{-1} \ .$$

It is now well-known that Wy_m is correlated with the error term and, hence, endogenous (see Kelejian and Prucha, 1998). The associated bias can be overcome by two-stage-least squares (2SLS) using WX_m, W^2X_m, W^3X_m, etc., as instruments for Wy_m.[24] To guard against inefficient standard errors due to omitted interdependence of the error term as in equation (3), we use the non-parametric spatial heteroscedasticity and autocorrelation consistent (HAC) estimator by Kelejian and Prucha (2007) to estimate the VC matrix.[25]

[24] Our results are fairly robust to the choice among those instruments.
[25] See Appendix 1.B for the formulation of the 2SLS and the HAC estimator.

Table 1.8: Regression results for spatial IV-HAC estimation using geographic distance weights

Explanatory variables	***Mode 1***		***Mode 3***	
Wy	0.354	**	0.273	**
	(0.172)		(0.138)	
Log GDP (1993)	0.152	**	0.259	***
	(0.069)		(0.063)	
Log capital per capita (1993)	0.313	***	0.286	***
	(0.099)		(0.093)	
FTA	4.783		5.222	
	(4.845)		(4.262)	
PTA	-8.680	**	-5.582	
	(4.396)		(3.562)	
AD	0.000		-0.001	*
	(0.001)		(0.000)	
AD*	0.001		0.000	
	(0.001)		(0.001)	
EU	0.261		0.592	***
	(0.223)		(0.194)	
Constant	-7.457	***	-10.013	***
	(2.146)		(1.903)	
Countries	84		87	
Centered R^2	0.694		0.714	
Shea Partial R^2	0.737		0.744	

Notes: Standard errors in parentheses, based on non-parametric HAC estimation of sample moments. ***significant at 1%, ** at 5%, * at 10%. The dependent variable is the weighted coverage ratio of the respective mode. Sargan overidentification test: H_0 that instruments are valid is not rejected

Results for the spatial 2SLS estimation are reported in Table 1.8: We use the weighted coverage across all sectors as the dependent variable and the least parsimonious model specification (3) using capital-labour ratios instead of the schooling variable to cover the largest possible sample of countries. For both Mode 1 and Mode 3 the other countries (inverse-distance-weighted) weighted coverage ratio exhibits a positive coefficient as expected. Hence, there is support for herding behaviour in trade liberalisation: countries are more likely to liberalise service trade and FDI, if their major trading partners (or their neighbours) do so as well.

1.5 Conclusions

Previous studies on the determinants of specific commitments in GATS have been purely descriptive or confined to the financial sector. In this paper, we provide a first assessment of the economic fundamentals determining GATS commitments for cross-border trade and commercial presence in services across all service sectors.

Quite in contrast with the expectations from the perspective of general equilibrium models of trade and multinational enterprises, large and rich countries seem to be more keen on liberalising their barriers to trade and foreign commercial presence in the service sector. From a theoretical perspective, the expected welfare gains would be larger for small and poor economies. The negotiation process and, especially, issues related to the lack of comprehensive domestic regulation in service sectors of poor countries are possible explanations for this result.

Furthermore, we find that countries that were active in liberalising trade in the past (through participation in regional trade agreements) tend to commit to more extensive service liberalisation than others. Finally, there is significant herding behaviour in liberalising service transactions: countries are more likely to commit to more extensive liberalisations, if their natural trading partners/neighbours do so as well.

APPENDIX 1.A: Country Coverage

Table 1.9: 106 Countries by income group according to World Bank 1995

Weighted coverage of Mode 3 in percent

Low income (25)		Middle Income (47)		High Income (34)	
Bangladesh	0.5	Antigua and Barbuda	8.2	Aruba	11.7
Benin	5.0	Argentina	31.2	Australia	48.0
Burkina Faso	1.1	Bahrain	2.6	Austria	48.1
Cameroon	1.9	Barbados	3.5	Belgium	61.3
China	10.6	Belize	1.3	Brunei	4.4
Congo, Rep.	0.6	Bolivia	3.9	Canada	45.0
Cote d'Ivoire	4.5	Brazil	13.5	Cyprus	3.9
Ghana	14.2	Chile	11.5	Denmark	60.6
Guyana	10.2	Colombia	13.1	Finland	47.0
Honduras	6.0	Costa Rica	0.6	France	56.4
India	10.6	Cuba	14.7	Germany	61.7
Kenya	5.3	Czech Republic	23.9	Hong Kong, China	30.4
Madagascar	0.8	Dominica	2.1	Iceland	48.5
Mozambique	5.8	Dominican Republic	20.6	Ireland	60.0
Myanmar	0.0	Egypt, Arab Rep.	6.9	Israel	24.8
Nicaragua	23.9	El Salvador	10.3	Italy	52.3
Niger	1.0	Fiji	0.2	Japan	53.1
Nigeria	13.3	Gabon	2.3	Korea, Rep.	36.4
Pakistan	9.3	Greece	55.5	Kuwait	27.9
Senegal	7.3	Grenada	2.1	Liechtenstein	40.6
Sri Lanka	0.3	Guatemala	4.5	Luxembourg	62.9
Tanzania	0.0	Hungary	45.2	Macao, China	12.1
Uganda	0.5	Indonesia	10.3	Netherlands	62.6
Zambia	10.3	Jamaica	7.0	Netherlands Antilles	14.3
Zimbabwe	9.8	Malaysia	16.7	New Caledonia	1.5
		Malta	0.9	New Zealand	39.2
		Mauritius	3.2	Norway	46.3
		Mexico	17.5	Portugal	49.5
		Morocco	20.0	Singapore	22.5
		Namibia	1.9	Spain	56.7
		Paraguay	5.2	Sweden	43.8
		Peru	9.6	Switzerland	51.8
		Philippines	13.3	United Kingdom	62.5
		Poland	24.5	United States	49.0
		Romania	23.9		
		Slovak Republic	24.6		
		South Africa	38.5		
		St. Lucia	4.2		
		St. Vincent and the Grenadines	3.4		
		Suriname	2.6		
		Swaziland	5.8		
		Thailand	15.8		
		Trinidad and Tobago	6.8		
		Tunisia	1.5		
		Turkey	20.4		
		Uruguay	13.8		
		Venezuela, RB	15.8		

APPENDIX 1.B: Spatial HAC Estimator

Following Kelejian and Prucha (2007), we write the model more compactly in matrix form as $Z=(X,Wy)$, $\delta_0^{'}=(\beta^{'},\lambda_0)$ and define H as an $n \times p$ non-stochastic matrix of instruments. If we furthermore write $\hat{Z}=H(H'H)^{-1}H'Z$, then, we obtain the following expression for the spatial instrumental variable two-stage least-squares (IV-2SLS) estimator:

$$\hat{\delta}=(\hat{Z}'Z)^{-1}\hat{Z}'y .$$

Kelejian and Prucha (2007) show that a consistent estimator of the variance-covariance (VC) matrix of the parameter vector $\delta_0^{'}$ is:

$$\hat{\Phi}=n(\hat{Z}'\hat{Z})^{-1}Z'H(H'H)^{-1}\hat{\Psi}(H'H)^{-1}H'Z(\hat{Z}'\hat{Z})^{-1}.$$

$\hat{\Psi}$ is the estimated VC matrix for the sample moment $\Psi=n^{-1}H'\Omega_u H$. The spatial HAC estimator for element (r,s) of the true VC matrix Ψ is then:

$$\hat{\psi}_{r,s}=n^{-1}\sum_{i=1}^{N}\sum_{j=1}^{N}h_{ir}h_{js}\hat{u}_i\hat{u}_j K(w_{ij}).$$

$K(w_{ij})$ is the Kernel weight w_{ij}, computed as $w_{ij}=e^{-\delta_{ij}}$, where δ_{ij} is the scaled distance between the most populated cities of countries in our case. We choose a Bartlett Kernel where w_{ij} is set to zero if the bilateral distance is smaller than the average distance in our sample.

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2 Estimating trade in intermediate goods and services and understanding its determinants*

2.1 Introduction

Trade in intermediate inputs has been steadily growing over the last decade. However, despite the internationalisation of production and the increasing importance of outsourcing and foreign investment, some studies have found little rise in intermediate goods trade as a share of total trade (Chen et al., 2005). A recent contribution by Bergstrand and Egger (2010) indicates that "because of a well-known absence of any comprehensive data set decomposing world trade flows by end-use –that is, final versus intermediate goods– economists have little systematic knowledge about the actual pattern of flows of final versus intermediate goods around the world". The authors also note that no previous studies have used the gravity model for intermediate inputs. In this paper, we build a dataset of trade in intermediate goods and services for 42 countries over the period 1995-2005. The two novelties of the dataset are i) the estimation of bilateral trade in intermediate services and ii) the addition of the using industry dimension, that allows estimating inter- and intra-industry gravity regressions.

In this paper, we assess the determinants of both trade in intermediate goods and trade in intermediate services. To measure trade in intermediate goods, we use the UN Broad Economic Categories (BEC) classification that distinguishes intermediates, consumption and capital goods at the SITC 5-digit level. To estimate bilateral trade in intermediate services, we combine services trade data with OECD input-output tables. To our knowledge, this is the first study providing estimates for bilateral trade in intermediate services. A second main contribution of this paper is the decomposition of trade flows by using industry. We use input-output tables to distribute bilateral trade in intermediates over using industries. This allows estimating gravity models for intra-industry trade in intermediates and for inter-industry trade in intermediates. The dataset obtained covers the period 1995-2005 for 42 countries and is organised around five dimensions: (i) reporter; (ii) partner; (iii) year; (iv) industry of origin; and (v) using industry.

In pooled gravity regressions, we find that trade costs matter more for intermediate goods than for consumption goods. However, in regressions by industry the opposite pattern is found for some industries pointing to the importance of industry and product characteristics in explaining trade

* This chapter is joint work with Sébastien Miroudot, Organisation for Economic Co-operation and Development (OECD).

patterns. Regarding the importance of market size, results show that the size of the importing country has a larger effect on imports of consumption goods than of intermediate goods. Finally, including foreign direct investment stocks as explanatory variables in regressions, we find a complementarity relationship between bilateral inward FDI and bilateral imports, with the relationship being stronger for intra-industry imports.

The remainder of this paper is as follows. Section 2.2 discusses the methodology used to obtain a comprehensive dataset of bilateral trade flows of intermediate goods and services by product and by using industry. Section 2.3 describes the data and Section 2.4 provides stylised facts of trade in intermediate inputs. Section 2.5 presents an analysis of the determinants of trade in intermediate inputs using gravity regressions. Section 2.6 further investigates the relationship between trade in intermediates and activities of MNEs. Section 2.7 concludes.

2.2 Methodology used to construct the Dataset

2.2.1 Trade in Intermediate Goods: BEC Classification

Regarding trade in goods, we identify bilateral trade flows of intermediates at the SITC 5-digit level by using the UN Broad Economic Categories classification (BEC). The BEC classification assigns SITC Rev. 3 commodities to 19 basic categories of goods, 8 of which are categories of intermediate goods (see Table 2.1 in Appendix 2.B). Table 2.2 furthermore shows that at the SITC 5-digit level, out of 3,035 lines, 1,854 are intermediate goods, 696 are consumption goods and 471 capital goods. There are also 14 lines not classified for products that cannot be defined as mainly intermediate or mainly final, such as motor spirit or passenger motor cars.[26] For instance, passenger motor cars are consumption goods if they are used by private households and capital goods if they are used by firms.

An unavoidable drawback of BEC is that the allocation of commodities is based on "expert judgment", which is by nature subjective. Many goods might be both final and intermediate depending on the context. For instance, wheat flour belongs to BEC 121 –Processed food and beverages mainly for industry– and is hence classified as intermediate. Despite being an important input for the food industry, flour is also a consumption good for many households. The advantage of using the BEC classification is that bilateral trade in intermediates can be directly calculated from trade statistics that are readily available. Moreover, the data obtained are disaggregated (3,035 SITC lines). Bergstrand and Egger (2010) use the BEC classification to

[26] Table 8 in the Appendix provides the distribution of SITC lines in 17 industries.

capture trade in intermediate goods and to analyse the growth of FDI relative to trade. A similar approach has been taken by Yeats (2001). He provides his own breakdown of the SITC classification into final and intermediate goods in order to assess trade in parts and components.

2.2.2 Trade in Intermediate Services: Combining Trade Data with Input-Output Tables

While the BEC classification enables the identification of intermediate goods, no similar classification is available for trade in services. The reason for this is the high level of aggregation in services trade data. While goods trade data are based on customs declarations allowing the identification of goods at a highly disaggregated level, services trade statistics are based on balance of payments data which do not provide such a detailed breakdown. For instance, the Extended Balance of Payments Services (EBOPS) classification category for telecommunication services does not distinguish between private and business calls.

To estimate trade in intermediate services we rely on input-output tables which have the advantage of providing a breakdown of services into intermediate services and services used for final consumption. More precisely, we multiply bilateral imports of services M_{ijpt} in industry p with the input-output coefficient γ_{ipt} indicating the share of intermediate inputs in imported services from industry p:

$$m_{ijpt} = \gamma_{ipt} M_{ijpt}$$

This formula assumes that the share of intermediate services in overall bilateral services imports of country i is the same across all exporting countries j. For instance, imagine that the transport industry consists of final passenger services and freight transport services that can be regarded as intermediates. If France has a share of imported inputs in overall transport imports of 79 percent, then it is assumed that this share applies to all partner countries. Hence, France's transport imports from both the United States and Japan are assumed to consist to 79 percent of freight services.

2.2.3 Trade in Intermediates by Using Industry

Besides not identifying trade in intermediate services, trade statistics have a further shortcoming compared to input-output tables. Trade data are collected according to the industry of origin and give therefore no indication on the using industry, i.e. the industry that is actually using the intermediate input in its production process. Intermediate goods and services are to a large extent

not only used within the same industry at higher stages in the production chain, but also by other industries. We use input-output tables to identify the using industry for both goods and services. Country input-output tables are presented in matrix format and show how much of the output of industry p is used as an input by industry k. Hence, the strength of input-output tables, as compared to trade data, is that they allow the identification of both the industry of origin and the using industry. Furthermore, input-output tables generally consist of a domestic and an import table indicating the use of domestic and imported inputs respectively. Hence, input-output tables contain information on the share of imports from industry p used as input in industry k. However, input-output tables are not bilateral, that is they do not reveal any information regarding trade partners.[27]

We add this dimension by combining bilateral imports of intermediates from trade data with the information on the usage of intermediate imports found in input-output tables. Hence, obtained import flows have five dimensions: importer i, exporter j, industry of origin (intermediate input) p, using industry k and year t. The imports of intermediate input p from country j by using industry k in country i can be expressed formally as:

$$I_{ijpkt} = \alpha_{ipkt} m_{ijpt}$$

where α_{ipkt} is the share of imported inputs p by using industry k in overall imported inputs p of country i (as calculated from input-output tables) and m_{ijpt} are the imports of input p of country i from country j (as identified in goods trade data using the BEC classification and in services trade data by combining it with input-output tables).

This allocation of bilateral intermediate imports across using industries assumes that import coefficients are the same for all trade partners. For instance, the research and development industry of Spain has a share of 0.03 percent in overall intermediate paper imports in 2004. This coefficient is then applied to intermediate paper imports from both Finland and Poland. Hence, the bilateral pattern of imported intermediates from industry p is the same across all using industries k. However, in the case of goods it is different from the bilateral pattern of total imports from industry p because the BEC classification allows distinguishing bilateral imports of intermediates from bilateral final good imports in industry p. Differently, since for services we have to assume that the share of intermediate services is the same across partner countries, this implies that the bilateral variation is the same for trade in intermediate and in final services.

[27] Notable exceptions are the US-Japan bilateral Input-Output tables from the Japanese Ministry of Economy and Trade and Industry and the database from the Japanese Institute of Developing Economies (IDE-Jetro), which has constructed international input-output tables for USA and Asian countries incorporating bilateral trade flows.

Input-output tables are multilateral, which means that they do not alter the geographic pattern when combined with bilateral trade data.

2.3 Data

Sources for trade data are the OECD International Trade by Commodity Statistics (ITCS) database for goods and the OECD Trade in Services by Partner Country database as well as the United Nations Service Trade Statistics Database for services. Lanz and Miroudot (2008) discuss characteristics and problems related to services trade data. A main shortcoming is that a large share of aggregate services trade cannot be allocated to specific partner countries and industries. Furthermore, often disaggregated data are not published due to confidentiality reasons. Hence, in many cases there is a large discrepancy between the sum of disaggregated trade flows and the aggregate value. While we cannot directly address any of these issues, we occasionally use mirror flows to increase the coverage of bilateral services flows at the sector level.

Input-output tables are taken from the 2009 edition of the OECD input-output database. They cover 42 countries representing more than 85 percent of world trade and are in most cases available for the years 1995, 2000 and 2005 (see Table 2.3 in the Appendix 2.B). Because input-output tables are not available yearly, we use interpolated values to produce time-series.[28] The advantage of the OECD input-output tables is that for most countries we have three tables and we can match precisely the input-output coefficients with trade flows from the same year.[29] While OECD input-output tables cover 48 industries in their original format, many countries actually report fewer industries.[30] To ensure the comparability of countries in the analysis, some industries are aggregated.[31] Table 2.4 in Appendix 2.B shows the 29 goods and services industries used in this study, including their correspondences in terms of original input-output industries and underlying ISIC Rev.3 categories. In Appendix 2.A, we furthermore explain how we have converted trade data from product classifications (EBOPS for services, SITC Rev.3 for goods) to the ISIC Rev.3 based industry classification used in input-output tables.

The dataset on trade in intermediate goods and services used in this paper is available on the OECD statistical portal (stats.oecd.org). For the gravity regressions, we use distance and bilateral dummy variables from CEPII and GDP from the World Development Indicators. Furthermore, we

[28] We generally have tables for 1995 and 2005. If this is not the case, we do not extrapolate but keep the respective coefficient constant for a maximum of three years after the respective table. For instance, if a table is available for 2001 but not for 2005, we apply the 2001 coefficients to the years 2002-2004.
[29] An alternative input-output database is the GTAP database. However, in GTAP the input-output coefficients are often for distant years and are not systematically updated between versions (Daudin et al., 2009).
[30] See Yamano and Ahmad (2006) for a detailed description of the OECD input-output database.
[31] Even at this higher level of aggregation, countries are not fully harmonious in industry coverage.

add to the dataset bilateral FDI stocks at the industry level. These data are derived from OECD FDI statistics. More information on the sources and on the data estimated to obtain a consistent dataset can be found in Lanz and Miroudot (2008).

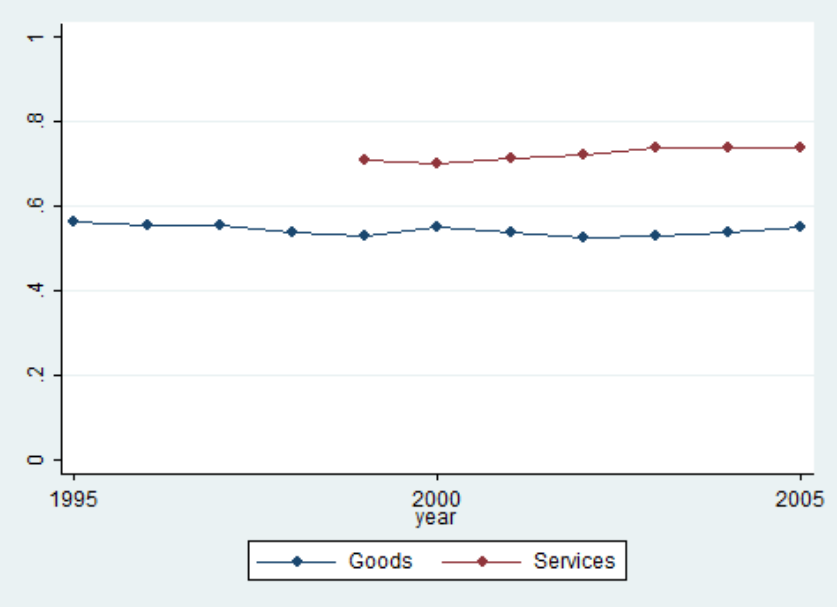
2.4 The Stylised Facts of Trade in Intermediate Goods and Services

In this section, we briefly describe some stylised facts on the patterns of trade in intermediate goods and services. Detailed tables at the region, country and industry level are available in Miroudot et al. (2009) and are not reproduced here.

The first stylised fact is that trade in intermediates has increased but that its share in total trade has remained constant. Trade in intermediates represents 56.2 percent of trade in goods and 73.2 percent of trade in services in our dataset. Hence, world trade flows are mainly comprised of inputs rather than final consumption goods or services. The growth rate of trade in intermediates has been significant over the last decade. For goods, the average annual growth rate in OECD countries between 1995 and 2005 has been 6.2 percent (in volume), a rate higher than output growth. For cross-border trade in services, a slightly higher average growth rate (7 percent) is observed. There is no marked difference in the growth rates of the different categories of goods (intermediate, consumption, capital goods). They have been following the general increase in total trade. As a consequence, the share of trade in intermediates in total trade has remained largely unchanged (see Figure 1.1). An apparent explanation to this paradox is that trade in both final and intermediate goods have been boosted by the internationalisation of production. In the case of services sectors, there is a slight difference between the growth rate of total trade and trade in intermediates leading to an increase of the share of intermediate services traded. This might suggest that outsourcing in services has indeed increased, but it remains to be seen if this trend holds into the future.

The second stylised fact is that trade in intermediate inputs is mainly intra-regional. The largest value of transactions is recorded within three regions: Europe, North America and Asia. Intra-regional imports are generally higher than inter-regional imports. This is especially the case in Europe with European intra-regional imports of intermediates being close to four time those of North America. It should be noted however that we have included intra-EU trade.

Figure 1.1: Share of intermediate trade in total trade (1995-2005)



Regarding inter-regional trade, we observe the following patterns. Asia is a net exporter of intermediate goods to Europe and to North America. Between Europe and North America, the pattern is the opposite for goods and services. Europe imports more intermediate services from North America but exports more intermediate goods. As some of the flows are related to exchanges of primary resources, such as oil or gas, the largest inter-regional flow for intermediate goods trade is exports from the Middle East and North Africa to Asia. But overall trade in intermediate inputs is mostly between developed countries and flows with developing economies are very small.

The third stylised fact is that the distribution of trade in intermediates across industries differs if we look at the industry of origin or the using industry. Table 2.5 gives the shares of industries in total intermediate imports (5,309 Billion USD) as calculated for 34 countries. The 'Mining and quarrying industry' has the highest trade share as industry of origin (18.6 percent), while the 'Refined petroleum and other treatments industry' has the highest one as using industry (11.7 percent). This result is not surprising since the 'Mining and quarrying industry' produces crude oil which is then used as intermediate input by the 'Refined petroleum and other treatments industry'. In general, goods industries have a higher trade share as industry of origin as compared to services industries. On the other hand, some services industries such as 'Other services' (7.8 percent), Construction (5.1 percent), Transport (5.4 percent) or 'Trade and repairs' (4.7 percent) have rather high shares in overall trade as using industries. This pattern can be explained by the fact that cross-border trade is still dominated by goods. It does however not imply that services

industries use more goods inputs as goods industries use services inputs. Goods industries may often source services inputs locally from either domestic or foreign companies. Hence, foreign services inputs are often supplied not via cross-border trade (mode 1 in GATS terminology) but through a commercial presence in the host economy (i.e. through mode 3).

Table 2.5: Share of industries in total imports of intermediates

	Share in total intermediate trade	
Industry	Ind. of origin	Using industry
Agriculture and fishing	2.2%	1.4%
Mining and quarrying	18.6%	1.3%
Food products	1.3%	3.3%
Textiles and wearing apparel	2.0%	2.3%
Wood,publishing and printing	3.4%	3.1%
Refined petroleum	1.0%	11.7%
Chemical products	12.5%	7.1%
Rubber and plastic products	2.6%	2.4%
Metal products	9.5%	7.4%
Mechanical products	4.4%	4.0%
Office machinery and computers	2.5%	2.2%
Radio,TV,communication	3.4%	2.5%
Medical, precision, optical instr.	0.7%	0.7%
Motor vehicles	5.6%	7.7%
Other transport equipments	1.5%	1.6%
Other manufacturing	6.5%	4.7%
Electricity, gas and water	0.4%	4.1%
Construction	0.2%	5.1%
Trade and repairs	0.9%	4.7%
Hotels and restaurants	5.3%	1.0%
Transport, storage & aux.	5.9%	5.4%
Post and telecommunications	0.5%	1.4%
Finance	2.2%	2.3%
Real estate	n.a.	0.9%
Renting of machinery and equip.	0.3%	0.3%
Computer activities	0.4%	0.8%
Research and development	0.6%	0.5%
Other business activities	4.6%	2.4%
Other services	0.9%	7.8%

Note: For some countries trade flows are missing for certain industries and the shares as origin industry are underestimated.

A last comment is that often foreign inputs are mainly used within the same industry (i.e., the foreign industry which produces the intermediate input is the same as the one using it in the importing economy). In 17 of the 29 industries covered in our dataset, more than one third of total

imports of inputs are used within the same sector. We will look in the quantitative analysis at 'intra-industry intermediate trade'.

2.5 The Determinants of Trade in Intermediate Goods and Services

The descriptive statistics presented in Section 2.4 are useful to understand the nature of trade flows in intermediates but they do not provide information on the motivations for firms to trade or establish abroad. To provide some insights on the determinants of trade in intermediate goods and services, we estimate gravity regressions that can be derived from various trade models. In particular, Bergstrand and Egger (2007) derive both trade and FDI gravity equations from the "knowledge-and-physical-capital model" and justify their simultaneous estimation. In Bergstrand and Egger (2010) they furthermore incorporate intermediate goods into their model. Along the same lines, we estimate the gravity model by goods type.

2.5.1 Gravity Regressions at the Industry Level

In order to identify differences in trade in intermediates and trade in final goods and services, we estimate the following gravity model with fixed effects at the industry level:

$$\ln(m_{ijpt}) = \beta_0 + \beta_1 \ln(distance_{ij}) + \sum_{n=2}^{4} \beta_n dummy_{ij} + \beta_5 \ln(GDP_{it}) + \beta_5 ln(GDP_{jt}) + \gamma_i + \eta_j + \lambda_t + \kappa_p + \varepsilon_{ijpt}$$

where m_{ijpt} are bilateral imports of total, intermediate or consumption goods/services (or capital goods), $distance_{ij}$ is the geographical distance between bilateral partners (a proxy for trade costs), $dummy_{ij}$ refers to a set of bilateral dummy variables accounting for common language, common border and past colonial relationship (the source is CEPII), importer (GDP_{it}) and the exporter (GDP_{jt}) Gross Domestic Product proxy for market size and γ_i , η_j, κ_p and λ_t are respectively the importer, exporter, industry and year fixed effects.

Table 2.6 presents the results from regressions on goods imports while Table 7 shows respective results for services imports. Flows of intermediate and final products are on average affected by the same type of frictions and respond positively to the same determinants. The gravity model explains successfully both types of trade flows. However, the impact of trade costs and market size differs for intermediate imports as well as between goods and services industries.

Table 2.6: Gravity regressions at the industry level - Imports of goods

	Total	Intermediate	Consumption	Capital	Intra-industry
	(1)	(2)	(3)	(4)	(5)
Distance	-0.826****	-0.909****	-0.831****	-0.653****	-0.928****
	(0.029)	(0.029)	(0.042)	(0.036)	(0.027)
Common border	0.478****	0.456****	0.416****	0.494****	0.439****
	(0.072)	(0.069)	(0.087)	(0.100)	(0.073)
Common language	0.119	0.170**	0.192*	0.047	0.124*
	(0.075)	(0.073)	(0.100)	(0.092)	(0.073)
Past colonial rel.	-0.197	-0.390*	0.484****	0.024	-0.308
	(0.209)	(0.219)	(0.176)	(0.195)	(0.188)
GDP importer	0.669****	0.547****	0.893****	0.711****	0.562****
	(0.073)	(0.078)	(0.067)	(0.132)	(0.097)
GDP exporter	0.588****	0.563****	0.537****	0.917****	0.445****
	(0.067)	(0.060)	(0.079)	(0.156)	(0.071)
Pseudo R-squared	0.743	0.727	0.798	0.82	0.77
Observations	625,967	625,967	578,677	367,752	625,967

Notes: Poisson maximum likelihood regressions including country, time and industry fixed effects. Standard errors clustered for country pairs are reported parentheses. *significant at 10%, ** at 5%, *** at 1%, **** at 0.1%.

Table 2.7: Gravity regressions at the industry level - Imports of services

	Total	Intermediate	Final	Intra-industry
	(1)	(2)	(3)	(4)
Distance	-0.756****	-0.766****	-0.910****	-0.716****
	(0.040)	(0.041)	(0.056)	(0.038)
Common border	0.161	0.155	-0.119	0.004
	(0.102)	(0.101)	(0.137)	(0.109)
Common language	0.337****	0.381****	0.208*	0.392****
	(0.102)	(0.104)	(0.112)	(0.108)
Past colonial rel.	-0.024	0.011	-0.234	-0.259*
	(0.202)	(0.221)	(0.221)	(0.152)
GDP importer	0.835****	0.793****	0.347	0.813****
	(0.118)	(0.141)	(2.561)	(0.214)
GDP exporter	0.358****	0.441****	-0.487	0.483****
	(0.078)	(0.119)	(1.842)	(0.117)
Pseudo R-squared	0.83	0.815	0.766	0.785
Observations	84,437	84,437	84,437	84,406

Notes: Poisson maximum likelihood regressions including country, time and industry fixed effects. Standard errors clustered for country pairs are reported parentheses. *significant at 10%, ** at 5%, *** at 1%, **** at 0.1%.

A notable difference between trade in intermediates and trade in consumption goods can be seen when looking at the impact of market size (the GDP importer coefficient). Consumption goods are traded more according to the size of the import market than intermediate goods. This is not a surprising result as companies export to sell to a large number of final consumers while inputs can

be very specialised and profitable to export to smaller markets from where final products may then be shipped to third countries.

Distance is a proxy for trade costs between two countries. These trade costs consist to a large part of transport costs for goods but also of other distance-related costs. Miroudot and Ragoussis (2009) point out that distance can also capture regulatory differences (e.g., trade policies, market regulations, national business laws) as well as cultural differences between countries. The importance of distance-related trade costs other than transport costs can be seen by the impact of distance on services imports, which is often larger than for goods imports despite the lack of a 'transport' cost.

Distance has a negative and significant impact on both goods and services imports of total, intermediate and final products. There are however differences in the size of coefficients. As can be seen in Table 2.6, trade in intermediate goods (col. 2) is more sensitive to trade costs as compared to consumption goods (col. 3). A 10 percent increase in distance between two countries decreases intermediate goods imports by 9.1 percent as compared to 8.3 percent and 6.5 percent for consumption and capital goods imports respectively. This result is not confirmed for services where on the contrary we observe a higher distance coefficient in the case of final services.

In order to disentangle the effect of transport costs and trade policy barriers, two alternative variables are used instead of distance in the gravity regression of goods imports: the ratio of the cif to fob trade values as a proxy for transport costs, and simple averages of applied bilateral tariffs as a proxy for trade barriers. The results are presented in Table 2.8. It should be noted that the sample size in Table 2.8 is smaller than the one in Table 2.6 due to the limited availability of cif-fob factors and bilateral tariffs. The coefficient of the cif-fob variable is negative and highly significant for all variables except for consumption imports. The negative impact of transport costs as measured by the cif-fob ratio on imports is larger for intermediate goods (as opposed to consumption and capital goods). Bilateral tariffs have a negative impact on all type of imports and particularly on capital goods. The effect of tariffs is larger on trade in intermediates than on trade in consumption goods. Hence, Table 2.8 supports the result that trade in intermediate goods is relatively more sensitive to trade costs than consumption goods.

This higher sensitivity of intermediates imports to trade costs, including both transport costs and trade barriers, can be interpreted in several ways. First, production networks are subject to geographic and time constraints so that distance can have a more detrimental impact on the decision to trade for intermediate goods compared to final goods. When assembling complex goods, being remote is a larger handicap than when supplying consumers with a given good as more interactions are observed between companies and their suppliers than with final consumers.

"Just in time" production and other "lean" production processes are less able to accommodate hazards introduced by distance. In the context of production networks, this result confirms Grossman, Helpman and Szeidl (2006). They analyse the integration strategies of heterogeneous firms in a three country model where goods are produced in two stages, i.e. in an intermediate stage and a final assembly stage. They point to the importance of what they call agglomeration complementarity: if intermediate goods are costly to transport, then firms will tend to locate the production of intermediates nearby the location of the assembly of the final good. Similarly, Hilberry and Hummels (2002) extend a new economic geography model of Krugman and Venables (1996) in which trade frictions lead to co-location between final good producers and suppliers and show that intermediate goods are traded more locally than consumption goods. Finally, we find that for capital goods the elasticity of distance to trade is lowest. Possible explanations might be that capital goods are of a durable nature and maybe less prone to short term costs.

Table 2.8: Gravity regressions using trade costs and tariffs instead of distance

	Total	Intermediate	Consumption	Capital
	(1)	(2)	(3)	(4)
CIF-FOB	-0.114****	-0.136****	-0.049*	-0.067****
	(0.022)	(0.017)	(0.029)	(0.020)
Tariff	-0.243****	-0.262****	-0.192****	-0.431****
	(0.054)	(0.060)	(0.053)	(0.083)
Common border	1.431****	1.412****	1.480****	1.444****
	(0.130)	(0.124)	(0.163)	(0.158)
Common language	0.104	0.223**	0.071	0.029
	(0.096)	(0.103)	(0.137)	(0.113)
Past colonial rel.	0.431****	0.243	0.835****	0.348*
	(0.140)	(0.174)	(0.159)	(0.189)
GDP importer	0.511****	0.423****	0.789****	0.644****
	(0.111)	(0.114)	(0.109)	(0.211)
GDP exporter	0.668****	0.564****	0.473****	1.152****
	(0.109)	(0.095)	(0.095)	(0.191)
Pseudo R-squared	0.698	0.657	0.736	0.776
Observations	212,383	179,862	134,768	66,213

Notes: Poisson maximum likelihood regressions including country, time and industry fixed effects. CIF-FOB ratios and tariffs are specific to each good type and are measured as: CIF-FOB= ln[(cif-fob)/fob]; Tariffs=ln(1+tariff rate). Standard errors clustered for country pairs are reported parentheses. *significant at 10%, ** at 5%, *** at 1%, **** at 0.1%.

To test whether results from pooled regressions are confirmed at a more disaggregate level, we report results for regressions by industry in Table 2.9 using either intermediate or consumption imports as the dependent variable. The following main observations can be made. First, rather large differences in coefficients across industries point to industry heterogeneity regarding trade costs and market size. For instance, in the case of intermediate imports, 'Wood, publishing and

printing' has a much higher distance coefficient than 'Other transport equipment', i.e. -1.2 versus -0.3 respectively. Second, while in pooled regressions we find a larger impact of distance on trade in intermediates as compared to consumption goods, this is not generally the case in regressions by industry. Hence, in some industries imports of final consumption goods tend to be more sensitive to distance than imports of intermediate goods. Industry specific factors might explain these results. For instance, time may not only be a crucial factor within a production network but also between a firm and consumers. For instance, fresh food and trendy clothes are very sensitive to time and hence distance. Furthermore, in some industries such as 'Mechanical products', the final good might be heavy and hence difficult to transport (and will be assembled close to consumer markets). Third, Table 2.9 confirms that both importer and exporter market sizes typically have a higher impact on consumption imports than on intermediate imports. Fourth, for all industries but 'Mechanical products', the GDP of the importing country has a larger impact on intermediate imports than the exporter GDP. In the case of consumption imports, there is no homogeneous pattern for the relative importance of importer and exporter GDP across industries.[32]

[32] Results should be treated with caution since the theoretical gravity model actually asks for the use of industry demand and output data instead of GDPs.

Table 2.9: Gravity regressions by industry - Intermediate versus consumption imports

	1. Agriculture and fishing	3. Food products	4. Textiles and wearing apparel	5. Wood, publishing and printing	7. Chemical products	8. Rubber and plastic products	9. Metal products	10. Mechanical products	12. Radio,TV,communication equipments	13. Medical, precision and optical instruments	15. Other transport equipments	16. Other manufacturing
Dependent variable: Intermediate imports												
Distance	-0.909***	-0.894***	-1.051***	-1.212***	-0.928***	-1.168***	-0.998***	-0.810***	-0.638***	-0.712***	-0.316***	-0.990***
	(0.059)	(0.055)	(0.045)	(0.047)	(0.044)	(0.040)	(0.039)	(0.037)	(0.043)	(0.040)	(0.075)	(0.042)
Common border	0.726***	0.585***	0.370***	0.539***	0.109	0.474***	0.619***	0.360***	0.452***	0.246*	0.678***	0.361***
	(0.122)	(0.101)	(0.100)	(0.085)	(0.104)	(0.080)	(0.080)	(0.075)	(0.133)	(0.110)	(0.201)	(0.106)
Common language	-0.149	0.269*	0.245*	-0.033	0.09	0.134	0.078	0.266***	0.13	0.273*	0.152	0.092
	(0.124)	(0.121)	(0.112)	(0.092)	(0.113)	(0.085)	(0.120)	(0.080)	(0.093)	(0.109)	(0.124)	(0.160)
Past colonial rel.	1.149***	1.524***	-0.529	-0.302	-0.038	-0.22	-0.14	-0.002	-0.146	0.212	0.382	0.148
	(0.201)	(0.203)	(0.345)	(0.396)	(0.294)	(0.318)	(0.271)	(0.202)	(0.133)	(0.209)	(0.316)	(0.229)
GDP importer	0.809***	0.369**	0.585***	0.683***	0.535***	0.622***	0.732***	0.428***	0.709**	0.394	-0.102	0.777***
	(0.143)	(0.119)	(0.085)	(0.109)	(0.101)	(0.111)	(0.083)	(0.108)	(0.230)	(0.202)	(0.206)	(0.120)
GDP exporter	-0.02	-0.138	0.472***	0.053	0.531***	0.499***	0.237**	0.669***	0.585**	0.457*	0.309*	0.683***
	(0.109)	(0.090)	(0.067)	(0.113)	(0.119)	(0.126)	(0.088)	(0.091)	(0.202)	(0.224)	(0.135)	(0.117)
R-squared	0.837	0.82	0.897	0.938	0.935	0.937	0.892	0.951	0.913	0.925	0.922	0.922
Number of obs.	52,006	46,929	51,401	46,784	43,387	36,729	43,661	43,848	34,362	35,972	27,130	49,897
Dependent variable: Consumption imports												
Distance	-1.394***	-1.036***	-1.152***	-0.917***	-0.765***	-1.093***	-0.744***	-1.166***	-1.315***	-0.199*	-0.654***	-0.732***
	(0.066)	(0.051)	(0.128)	(0.060)	(0.061)	(0.066)	(0.091)	(0.085)	(0.086)	(0.080)	(0.071)	(0.078)
Common border	0.179	0.404***	0.175	0.450**	0.112	0.521***	0.315*	0.219	0.055	0.307	0.694***	0.715***
	(0.117)	(0.118)	(0.150)	(0.142)	(0.111)	(0.113)	(0.137)	(0.112)	(0.146)	(0.171)	(0.171)	(0.125)
Common language	-0.099	0.315**	0.446**	0.596***	0.167	0.096	0.336*	0.26	-0.168	0.227	0.116	0.246
	(0.142)	(0.104)	(0.136)	(0.138)	(0.199)	(0.109)	(0.166)	(0.138)	(0.184)	(0.164)	(0.168)	(0.141)
Past colonial rel.	1.555***	0.986***	0.418*	0.489*	-0.23	0.342	0.284	-0.462	-0.779*	0.381*	-0.564*	0.595**
	(0.196)	(0.221)	(0.188)	(0.220)	(0.220)	(0.253)	(0.247)	(0.575)	(0.341)	(0.193)	(0.223)	(0.192)
GDP importer	0.980***	0.875***	0.955***	0.750***	0.420***	0.509**	0.935***	0.732***	1.071***	0.940***	1.041***	0.985***
	(0.075)	(0.093)	(0.127)	(0.131)	(0.113)	(0.165)	(0.134)	(0.165)	(0.238)	(0.275)	(0.285)	(0.097)
GDP exporter	0.032	0.202**	0.699***	0.329*	0.886*	0.645***	1.285***	1.130***	0.523**	0.694**	0.615**	1.023***
	(0.052)	(0.074)	(0.061)	(0.156)	(0.388)	(0.113)	(0.207)	(0.167)	(0.168)	(0.231)	(0.237)	(0.108)
R-squared	0.871	0.907	0.923	0.902	0.912	0.911	0.894	0.915	0.861	0.897	0.879	0.944
Number of obs.	52,006	46,929	51,401	46,784	43,387	36,729	43,661	43,848	34,362	35,972	27,130	49,897

Notes: Dependent variables are either intermediate or consumption imports as identified by the UN BEC classification. Poisson maximum likelihood regressions include country and year fixed effects. Clustered standard errors inside parentheses allow interdependence of observations within country pairs. *significant at 5%, **significant at 1%, ***significant at 0.1%

2.5.2 Trade in Intermediates and the Activities of Multinational Enterprises

The economic literature distinguishes two basic forms of multinational enterprise (MNEs) activity, i.e. vertical and horizontal FDI. Vertical MNEs exploit differences in factor prices across countries while horizontal MNEs are attracted by the market and emerge as a consequence of trade costs. Vertical MNEs (see Helpman, 1984, and Helpman and Krugman, 1985, for seminal contributions) split up the production process into two or more production stages across countries so that trade in intermediate inputs is a direct consequence. Horizontal MNEs replicate the production process in different countries in order to save on trade costs. Hence, in horizontal models (see Markusen, 1984, Brainard, 1997 and Markusen and Venables, 2000) MNEs have their headquarter in the home country and a plant in both the home and the host country where the final goods are produced and then sold to local consumers.

How may bilateral FDI affect bilateral imports of intermediate goods and services? In the case of vertical inward FDI, a foreign MNE decides to locate a stage of its production process in the importing country. If the affiliate relies on inputs from its parent company, then imports in form of bilateral intra-firm trade will increase. Furthermore, vertical inward FDI might also increase bilateral inter-firm, i.e. arm's length trade, if the affiliate sources intermediates from an independent supplier of the foreign country. For instance, if a firm moves parts of its production abroad, existing local suppliers will have to export their inputs to the respective country. When considering outward FDI, the perspective of the importing country changes: a domestic MNE locates a stage of production abroad to reduce costs. In this case, the effect on bilateral imports is less clear. Bilateral imports will increase if the intermediate output of the foreign affiliate is shipped back home. However, if the output of the foreign affiliate is shipped to a third country, the imports of the home country will remain unaffected. Moreover, if outward FDI is seeking proximity to foreign suppliers, bilateral imports of intermediates might even decrease, because foreign suppliers will stop shipping their products to the home country. According to this reasoning, inward FDI should lead to an increase in imported inputs, while the impact of outward FDI is less clear. Apart from vertical, the motive for FDI might also be mainly horizontal, i.e. market seeking. Under such circumstances, only inward FDI may result in an increase in imported inputs but not outward FDI. Since the output of a horizontal affiliate is sold in the foreign or to third markets, no intermediate goods will be shipped back to the home country.

The economic literature has generally found a positive relationship between MNE activity and trade in intermediates. Head and Ries (2001) look at 932 Japanese manufacturing firms for the period 1966-1990. They find that FDI of vertically integrated firms tend to increase more firms' exports than FDI of firms that are not vertically integrated. Blonigen (2001) uses product level

data to show that Japanese-owned automobile production in the United States is positively related to U.S. imports of automobile parts from Japan. However, he also finds that Japanese owned-production of automobiles parts in the U.S. replaces imports of Japanese parts. To analyse the relationship between the operations of MNEs and trade in intermediates, we follow the approach taken by Kleinert (2003). He tests for sourcing strategies of MNEs by including inward and outward FDI stocks as explanatory variables in a regression explaining trade in intermediates. By relying on aggregate trade and FDI data of six OECD countries, Kleinert finds some evidence that inward FDI stocks have a significant positive impact on trade in intermediates as measured by input-output tables. In contrast, he finds no robust effect of outward FDI on intermediate imports of goods industries.

However, as rightly pointed out by Bergstrand and Egger (2010), FDI and trade in intermediates are simultaneously determined by decisions of MNEs based on factor endowments, trade costs and investment costs. This means that estimated coefficients of simple OLS regressions will be biased. In order to address this endogeneity problem, we rely on two-stage least-squares (2SLS) instrumental variable regressions. Thereby, we use lagged changes in FDI stocks as instruments. Changes in FDI stocks in the past should have no direct impact on today's trade in intermediates but only an indirect one through its impact on today's FDI stocks. In regressions, we test the validity of our instruments using overidentification tests. The new data used in this paper allow an analysis of how bilateral FDI impacts bilateral trade in intermediates at the industry level. Moreover, it allows distinguishing the impact of bilateral FDI on intra-industry ($p = k$) and inter-industry imports ($p \neq k$) of industry k. The regression estimated is:

$$ln\,(I_{ijpkt}) = \beta_0 + \beta_1 ln\,(Inward\ FDI_{ijk}) + \beta_2 ln\,(Outward\ FDI_{ijkt}) + \beta_3\, ln(distance_{ij}) + \sum_{n=4}^{6} \beta_n dummy_{ij} + \beta_7 ln\,(GDP_{it}) + \beta_8 ln\,(GDP_{jt}) + \gamma_i + \eta_j + \lambda_t + \kappa_k + \varepsilon_{ijkt}$$

Table 2.10 provides results for gravity models including bilateral inward and outward FDI stocks as additional explanatory variables. The first two columns show OLS and 2SLS regression results when bilateral intra-industry imports of industry k are used as dependent variable. In contrast, 2SLS models estimated in columns three to five have inter-industry imports as dependent variables, i.e. imports of inputs that have been produced by industries other than k. These are all inter-industry imported inputs (3), only manufacturing inputs (4) and only services inputs (5).

Bilateral inward FDI is found to have a positive effect on bilateral intermediate imports. The coefficient is significant in all models. Not surprisingly, the magnitude of the coefficient for inward FDI is rather small as compared to standard gravity variables, whose coefficients have the

expected sign and magnitude. According to model (2), a 1 percent increase in inward FDI increases imported inputs by 0.012 percent, while a 1 percent increase in distance leads to a 1.1 percent decrease in intra-industry imports. Conclusions regarding the impact of outward FDI are less clear. While its coefficient is significant and positive for intra-industry imports (col. 1 and col. 2), it is not significant for inter-industry imports except for services inputs. Hence, results seem to confirm our theoretical expectations that while inward FDI should have a robust positive impact on imported intermediates, the impact of outward FDI should be weaker and less clear. Another interesting finding is that the effect of inward FDI is larger for intra-industry as compared to inter-industry imports. This indicates that MNEs are more disposed to vertically integrate within the same industry than across industries. This result is in line with Alfaro and Charlton (2009), who find that most intra-industry FDI is vertical, even among developed countries and that firms are more likely to own production stages close to their own activity.

Table 2.10: Regression results for FDI and inter- and intra-industry trade

	Intra-industry imports		Inter-industry imports		
	OLS	2SLS	All	Manufacturing	Services
	(1)	(2)	(3)	(4)	(5)
Inward FDI	0.070****	0.012*	0.009**	0.008**	0.026****
	(0.003)	(0.007)	(0.004)	(0.004)	(0.006)
Outward FDI	0.045****	0.013**	-0.002	-0.004	0.018****
	(0.003)	(0.006)	(0.004)	(0.004)	(0.006)
Distance	-1.118****	-1.112****	-0.971****	-1.031****	-0.641****
	(0.012)	(0.016)	(0.010)	(0.009)	(0.014)
Common border	0.438****	0.512****	0.469****	0.406****	0.618****
	(0.027)	(0.035)	(0.021)	(0.021)	(0.031)
Common language	0.330****	0.407****	0.340****	0.373****	0.495****
	(0.026)	(0.035)	(0.021)	(0.020)	(0.031)
Past colonial rel.	-0.084	0.064	0.044	-0.138**	0.542****
	(0.077)	(0.107)	(0.068)	(0.062)	(0.056)
GDP importer	0.635****	0.823****	0.510****	0.524****	1.236****
	(0.072)	(0.121)	(0.067)	(0.065)	(0.113)
GDP exporter	0.489****	0.326****	0.267****	0.345****	0.272**
	(0.069)	(0.121)	(0.065)	(0.060)	(0.135)
R-squared	0.671	0.67	0.749	0.781	0.675
Observations	80,523	37,627	38,371	38,388	35,509

Notes: Robust standard errors inside parentheses. *significant at 10%, ** at 5%, *** at 1%, **** at 0.1%. All models have been estimated using reporter, partner, year and industry fixed effects. While model (1) is a simple OLS regression, models (2) to (5) are estimated by 2SLS using changes in FDI stocks of the previous three years as instruments. This also explains the smaller number of observations in 2SLS regressions as compared to the OLS regression. Overidentification tests did not reject the hypothesis of the validity of instruments in any specification.

2.6 Conclusions

In this paper, we have presented a comprehensive dataset of trade in intermediate goods and services for 42 countries over the period 1995-2005. The two novelties of the dataset are i) the estimation of bilateral trade in intermediate services and ii) the addition of the using industry dimension, that allows estimating inter- and intra-industry gravity regressions. Intermediate goods and services dominate world trade, accounting for 56.2 percent of trade in goods and 73.2 percent of trade in services in our dataset. However, despite the increasing international fragmentation of production the share of intermediates in total trade has remained almost constant since 1995.

Using gravity regressions, we find the following main results. In pooled regressions, trade costs have a larger negative impact on trade in intermediates as compared to trade in final consumption goods indicating the importance of trade costs for production networks. However, this is not generally the case in regressions by industry, which indicates that industries and products are heterogeneous regarding their sensitivity to time and trade costs. Furthermore, we find that the size of the importing country has a larger effect on imports of consumption goods than on intermediate goods. Finally, we find a complementarity relationship between bilateral inward FDI and bilateral imports, with the relationship being stronger for intra-industry imports.

Accounting correctly for trade in intermediates has an important impact on several research strands in international trade. One of the results of the gravity analysis regarding the relatively higher impact of trade costs on trade in intermediate goods has implications for the modelling of gains from trade (see for example Feltenstein and Plassmann, 2008). Another example of how measures of trade in intermediates can be helpful in the analysis is given by Johnson (2008) who argues that it could improve estimates of the factor content of trade. Finally, the main use of a comprehensive dataset on trade in intermediate goods and services should be the calculation of trade flows in value-added as carried out by recent research (Johnson and Noguera, 2009, and Daudin et al., 2009). A useful next step in the collection of empirical data on trade could also be an estimation of the share of intermediate inputs that are traded intra-firm. A ratio relating arm's-length trade in intermediates to intra-firm trade could be a key variable in the empirical analysis of MNE strategies.

Appendix 2.A: Correspondences

A major challenge in combining trade statistics with input-output tables is that imports have to be converted into the industry classification used in input-output tables. While input-output tables are classified according to industrial activity in terms of ISIC Rev. 3, trade data are compiled according to product classifications, i.e. SITC Rev.3 for goods and EBOPS for services. The quality of the correspondence is responsible for how well bilateral imports match the industry of origin in input-output tables. The more blurred the correspondence is, the more trade will be misallocated across industries, and hence the less adequate will be the import values assigned to using industries. Table 2.11 in Appendix 2.B reports the correspondences used to convert trade data that are recorded according to product classifications (EBOPS for services, SITC Rev.3 for goods) to the ISIC Rev.3 based industry classification used in input-output tables.

For goods, the correspondence between SITC Rev. 3 and BEC Rev. 3 allows identifying bilateral flows of intermediate products at the SITC 5-digit level. Then, the SITC-ISIC correspondence from the United Nations is used to identify trade in intermediate goods by industry. Since the latter correspondence is based on much disaggregated commodities, i.e. 5-and 4-digit SITC lines, we expect goods to match industries rather well. Industries are further aggregated into the ISIC based industry classification used in input-output tables. Table 2.2 in Appendix 2.B shows the number of SITC commodities corresponding to our industry classification. The table illustrates well that the number of traded intermediate goods is far higher as compared to consumption or capital goods.

In the case of services, bilateral imports are converted from EBOPS to the industry input-output classification. The EBOPS-ISIC correspondence has been adopted from the Manual on statistics of international trade in services (2002). The aggregate level of services trade data causes some difficulties for finding a suitable correspondence. For instance, some EBOPS codes correspond to more industries as defined by ISIC. Therefore, some input-output industries needed to be aggregated, e.g. 44 to 48 (containing health and education services among others). For the industry 'Other business activities' more than one suitable correspondence is possible and we used these different possibilities in order to increase the number of observations for which data are available.

However, we do not expect trade data to fully match imports as reported in input-output tables. One main reason is that while trade data are recorded at purchasing prices, imported intermediates in input-output tables are evaluated at basic prices. There are also other differences such as the treatment of re-exports, scrap metal, waste products and second hand goods or

unallocated trade data (see Guo et al., 2009, on these different issues). However, differences in trade values in input-output tables and trade data are not important for the methodology. More important is that the correspondence between the input-output coefficients and trade data is precise.

Appendix 2.B: Tables

Table 2.1: Broad Economic Categories classification of goods according to their main use

Classification by Broad Economic Categories (BEC)	Basic classes of goods in the System of National Accounts (SNA)
1 Food and beverages	
11 Primary	
111 Mainly for industry	Intermediate
112 Mainly for household consumption	Consumption
12 Processed	
121 Mainly for industry	Intermediates
122 Mainly for household consumption	Consumption
2 Industrial supplies not elsewhere specified	
21 Primary	Intermediate
22 Processed	Intermediate
3 Fuels and lubricants	
31 Primary	Intermediate
32 Processed	
321 Motor spirit	Not classified
322 Other	Intermediate
4 Capital goods (except transport equipment), and parts and accessories thereof	
41 Capital goods (except transport equipment)	Capital
42 Parts and accessories	Intermediate
5 Transport equipment, and parts and accessories thereof	
51 Passenger motor cars	Not classified
52 Other	
521 Industrial	Capital
522 Non-industrial	Consumption
53 Parts and accessories	Intermediate
6 Consumer goods not elsewhere specified	
61 Durable	Consumption
62 Semi-durable	Consumption
63 Non-durable	Consumption
7 Goods not elsewhere specified	Not classified

Table 2.2: Number of SITC commodities lines according to their main use

	Number of SITC commodities lines (classified according to main use)				
Industry	Overall	Intermediates	Consumption	Capital	Other
1. Agriculture and fishing	193	112	79	2	0
2. Mining and quarrying	75	75	0	0	0
3. Food products	299	113	186	0	0
4. Textiles and wearing apparel	375	205	169	0	1
5. Wood,publishing and printing	152	117	35	0	0
6. Refined petroleum & other treatments	17	15	0	1	1
7. Chemical products	483	446	37	0	0
8. Rubber and plastic products	70	58	12	0	0
9. Metal products	373	323	21	28	1
10. Mechanical products	395	108	28	252	7
11. Office machinery and computers	30	4	1	25	0
12. Radio,TV,communication equipments	70	33	6	31	0
13. Medical, precision and optical instruments, watches and clocks	130	42	26	62	0
14. Motor vehicles	33	16	2	14	1
15. Other transport equipments	56	14	14	26	2
16. Other manufacturing	281	170	80	30	1
17. Electricity, gas and water	3	3	0	0	0
All industries	**3,035**	**1,854**	**696**	**471**	**14**

Table 2.3: Country and year coverage of OECD input-output tables

Country	Years with I-O tables
Argentina	1997
Australia	1998/99, 2004/05
Austria	1995, 2000, 2004
Belgium	1995, 2000, 2004
Brazil	1995, 2000
Canada	1995, 2000
Switzerland	2001
China	1995, 2000, 2002, 2005
Czech Republic	2000, 2005
Germany	1995, 2000, 2005
Denmark	1995, 2000, 2004
Spain	1995, 2000, 2004
Estonia	1997, 2000, 2005
Finland	1995, 2000, 2005
France	1995, 2000, 2005
United Kingdom	1995, 2000, 2003
Greece	1995, 1999, 2005
Hungary	1998, 2000, 2005
Indonesia	1995, 2000, 2005
India	1993/94, 1998/99
Ireland	1998, 2000
Israel	1995
Italy	1995, 2000, 2004
Japan	1995, 2000, 2005
Korea	2000
Luxembourg	1995, 2000, 2005
Mexico	2003
Netherlands	1995, 2000, 2004, 2005
Norway	1995, 2000, 2001
New Zealand	1995/96, 2002/03
Poland	1995, 2000, 2004
Portugal	1995, 1999, 2000, 2005
Russia	1995, 2000
Slovak Republic	1995, 2000
Slovenia	2005
Sweden	1995, 2000, 2005
Turkey	1996, 1998, 2002
Chinese Taipei	1996, 2001
United States	1995, 2000, 2005
South Africa	1993, 2000

Table 2.4: Industry classification and correspondences with input-output (I-O) tables and trade data

Sector	Industry	I-O industry	ISIC Rev.3	EBOPS
1	Agriculture and fishing	1	1, 2, 5	
2	Mining and quarrying	2, 3	10, 11, 12, 13, 14	
31	PRIMARY SECTOR			
3	Food products	4	15, 16	
4	Textiles and wearing apparel	5	17, 18, 19	
5	Wood,publishing and printing	6, 7	20, 21, 22	
6	Refined petroleum & other treatments	8	23	
7	Chemical products	9, 10	24	
8	Rubber and plastic products	11	25	
9	Metal products	13, 14, 15	27, 28	
10	Mechanical products	16	29	
11	Office machinery and computers	17	30	
12	Radio,TV,communication equipments	19	32	
13	Medical, precision and optical instruments, watches and clocks	20	33	
14	Motor vehicles	21	34	
15	Other transport equipments	22, 23, 24	35	
16	Other manufacturing	12, 18, 25	26, 31, 36, 37	
17	Electricity, gas and water	26, 27, 28, 29	40, 41	
32	MANUFACTURING			
18	Construction	30	45	249
19	Trade and repairs	31	50, 51, 52	269
20	Hotels and restaurants	32	55	236
21	Transport, storage & auxiliary activities	33, 34, 35, 36	60, 61, 62, 63	205
22	Post and telecommunications	37	64	245
23	Finance	38	65, 66, 67	253, 260
24	Real estate	39	70	
25	Renting of machinery and equipment	40	71	272
26	Computer activities	41	72	263
27	Research and development	42	73	279
28	Other business activities	43	74	273-279
29	Other services	44, 45, 46, 47, 48	75, 80, 85, 90-93	264, 287, 291
33	SERVICE SECTOR			

Notes: For Computer activities and Other business activities alternative correspondences are used if services trade data do not allow above correspondence, i.e. EBOPS code 262 for Computer activities and EBOPS code 273 or 268-269-272 for Other business activities.

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3 Timeliness, product contractibility and comparative advantage in trade in intermediate goods*

3.1 Introduction

Trade in intermediate goods dominate trade flows constituting about 57 percent of world exports in 2000. This aggregate figure hides, however, significant differences across countries and products. While over 80 percent of Chile's exports are in intermediate products, 60 percent of US and Australia's exports and only just above 35 percent of China's exports are intermediate goods. Countries furthermore vary significantly in their share of intermediate exports within a sector. For example, in office machinery over 70 percent of Australian exports are intermediate products, whereas 40 percent of US exports and only around 10 percent of both Chilean and Chinese exports are intermediates.[33]

These data suggest that country and product characteristics can play a different role in explaining trade in final and intermediate goods. Hence, one contribution of this paper is that we assess the pattern of trade, i.e. a country's comparative advantage separately for trade in intermediate and trade in final goods. To distinguish between final consumption goods and intermediates we use the UN Broad Economic Categories (BEC) classification that categorises goods according to their main end use.[34] Then, to test for comparative advantage patterns in trade we apply a factor content of trade methodology developed by Romalis (2004) on a sample of 95 countries and their exports to the rest of the world disaggregated by 6-digit NAICS sectors.

Guided by recent economic literature that has emphasised countries' ability to enforce contracts and their ability to export within short time delays as important determinants of trade[35], we test whether these factors play a different role for trade in intermediates and trade in goods destined

* This chapter is joint work with Roberta Piermartini, World Trade Organization (WTO), and Elisa Gamberoni, World Bank.

[33] Figures 3.1 and 3.2 in the Appendix illustrate the mentioned shares for selected sample of countries.

[34] The BEC classification has also been applied by Bergstrand and Egger (2010) and Miroudot et al. (2009) to study trade in intermediates using gravity models.

[35] For example, Nunn (2007) finds that contract enforcement explains patterns of trade more than physical capital and skilled labour combined and Hummels (2001) finds that for developing countries export delays are more important than the average tariff faced by exporters.

to final consumption. Intuitively, if production occurs as a sequence of tasks and various inputs are all essential to the production of the final good, an input that is not of the required quality or is missing at the time when it is required will nullify the value of all other inputs/tasks. Therefore, no discount can compensate the producer of the final good for the unreliable delivery (Kremer, 1993). In contrast, when a good is imported for final consumption, it is plausible that the consumer may accept to buy it for a reduced price even if it is of a lower quality than required or if it is delivered with a delay.

Our results suggest that the quality of institutions, important for the enforcement of contracts, and the quality of transport infrastructure, important for timeliness in exporting, are sources of comparative advantage for trade in intermediate goods. Among these factors, the ability to timely delivery appears as the most important determinant for the pattern of trade in intermediates. Furthermore, we show that, compatible with the assumption of timeliness being most important for intermediates, the quality of transport infrastructure and hence time are major factors in explaining the differences in trade patterns of trade in intermediates and final goods. These results are robust to alternative measures for country and product characteristics. This suggests that improving institutions, investing in infrastructure, and fostering trade facilitation would significantly boost a country's participation, especially that of a developing country, in international production networks.

The rest of the paper is organised as follows. In Section 3.2, we discuss existing research regarding the importance of institutions and infrastructure for trade, and we motivate why these factors might affect differently trade patterns of intermediate and final goods. In Section 3.3, we present the empirical specification and discuss our methodological approach. In Section 3.4, we describe the data and provide summary statistics. In Section 3.5 we present and discuss our main results and robustness checks. Finally, Section 3.6 concludes.

3.2 Literature and Theoretical Motivation

3.2.1 Comparative Advantage in Institutions

Recent theoretical models of trade have highlighted the importance of contract enforcement and the cost associated with writing a contract for the decision of whether to source specialised inputs in-house or at arm's length (Antras, 2003; Antras and Helpman, 2004 and 2008; Grossman and Helpman, 2005). Besides the importance of the quality of institutions for the share of intra-firm

trade[36], the empirical literature has stressed the role of institutions as a factor of comparative advantage in trade in intermediate goods, as well as in trade in the final good using them (Levchenko, 2007; Antràs, 2005; Acemoglu et al., 2005; Costinot, 2005). Quality of institutions matters for comparative advantage in intermediate goods because it affects the costs of producing a customised good. Intuitively, if the production of an intermediate good requires specific investments to customise the input to the production of the final good, the value of the input is lower outside the supplier-buyer relationship than inside this relationship. Therefore, there is an incentive for the supplier to underinvest ex ante and produce lower quality goods.[37] This incentive is lower for suppliers located in countries with better contract enforcement. It follows that countries with a higher quality of institutions that provide better contract enforcement will have a comparative advantage in producing customised intermediate goods.

Although this theoretical literature defines the hold-up problem at the level of the intermediate input, the related empirical literature has focussed on trade in final goods using intermediates rather than on trade in intermediate goods themselves (Nunn, 2007; Levchenko, 2007).[38] These studies find that countries with better quality of institutions and hence better contract enforcement export relatively more in institutional-intensive sectors. Institutional-intensive sectors are identified as the final good sectors that use intensively inputs requiring relationship-specific investments (Nunn, 2007) or as final good sectors that are characterised by a high degree of complexity, as measured by the inverse of the Herfindhal concentration index of intermediate input usage, in the production process (Levchenko, 2007). The magnitude of relationship-specific investments matters because in the case of a standardised input the respective market is likely to be thick and hence there is limited scope for the hold-up problem to emerge. The degree of complexity of the production process matters because there are more relationships that are potentially affected by contracting imperfections.

We complement this literature by testing whether there is evidence that the hold-up problem matters for the patterns of trade in intermediate themselves. In particular, we test whether a country's ability to enforce a contract is more important as a determinant of comparative advantage in intermediate goods than in final goods. The rationale is based on the idea (first elaborated by Kremer, 1993) that underinvestment in the production of an intermediate good may

[36] Empirical studies assessing the determinants of the share of intra-firm trade include Bernard et al. (2010); Nunn and Trefler (2008); and Corcos et al. (2008).
[37] The hold up problem has been analysed for example by Williamson (1985), Grossman and Hart (1986) and Hart and Moore (1990).
[38] Institutional differences are found to be an important determinant of trade flows in a number of recent studies that use a gravity model of trade. For example, Anderson and Marcouiller (2002) and de Groot et al. (2004) show that quality of institutions significantly affects bilateral trade volumes and that better institutions are associated with higher volumes of trade. These models however do not look at institutions as factors affecting comparative advantage.

represent a much higher costs for the buyer when this is a processing firm than when it is a final consumer. For example, while a car manufacturer will not be able to accept to fit a cheap radio in a luxurious car, a consumer that has ordered an expensive radio may compromise on the quality if he gets an adequate discount.

To identify the degree of institutional intensity of a product, we use the Rauch (1999) classification that identifies whether the product, be it final or intermediate, is sold on an organised exchange, is reference priced or is not even reference priced. As suggested by Nunn (2007), the intuition is that if a product is sold on an organised exchange the market is thick consisting of many buyers and sellers so that the hold-up problem will not arise since either party has an outside option in the case of contract failure. On the other hand, if a product is not even reference priced, then the investments of both the final good producer and the supplier might be relationship-specific leading to the hold-up problem and underinvestment if contract enforcement is weak.

3.2.2 Comparative Advantage in Transport Infrastructure

Recent empirical research has stressed the importance of time as barrier to trade (Hummels, 2001; Hausman et al., 2005; Evans and Harrigan, 2005; Djankov et al. 2010; Portugal and Wilson, 2009; Freund and Rocha, 2010) and find a significant impact of time needed to export on trade flows. In these studies time-sensitive products, defined by their probability of being transported by air, being perishable or being related to fashion, are found to be more sensitive to time delays or distance.

Guided by this literature, we test whether a country's ability to export without long time delays, as captured by the quality of its transport infrastructure, is a significant determinant of comparative advantage in exports of intermediates rather than being simply a trade cost. In addition, we test whether such timeliness in exporting is a more important source of comparative advantage for trade in intermediates than for trade in consumption goods. The importance of timeliness of delivery has been particularly stressed in the literature of production networks, where production processes are characterised by just-in-time delivery (Nordas et al. 2006; Feinberg and Keane, 2007). We claim that timeliness matters for trade in intermediate goods as it is essential to manage the production chain. This implies that countries which can guarantee the timely delivery of intermediate inputs will have a comparative advantage in the production and exports of time-sensitive inputs. Products can be time-sensitive either because they are perishable, such as certain agricultural goods, because they are subject to volatility in consumer

demand such as fashion products in manufacturing[39], but also because there are inputs in a production chain. We measure the timeliness of a good by the share of U.S. imports that is shipped by air for this good. Intuitively, the more important time is for delivery, the more use will be made of air transport in trade.

3.3 Methodological Approach

In this paper, we test whether the quality of institution and the quality of infrastructure are sources of comparative advantage in trade, particularly for intermediate goods. Hence, we are not interested in explaining the volume of trade but rather in explaining the pattern of trade across industries and countries. To analyse the impact of these factors on trade patterns, we adopt the generalised functional form used in the most recent empirical literature. This includes the work of Romalis (2004), who assesses the importance of traditional factor endowments (capital and labour) as a source of comparative advantage for countries, and the studies of Nunn (2007) and Levchenko (2007), who show that countries with better institutions export relatively more in institutional-intensive industries. Furthermore, Djankov et al. (2010) adopt a similar specification to show that a country with shorter time delays in exporting tends to export relatively more time-sensitive goods. Following Nunn (2007), we adopt the subsequent empirical specification:

$$X_{ik} = \beta_0 + \beta_1 k_k K_i + \beta_2 h_k H_i + \beta_3 q_k Q_i + \beta_4 t_k T_i + \gamma_i + \mu_k + \varepsilon_{ik} \qquad (1)$$

where X_{ik} is the log of exports of country i to the world in the 6-digit NAICS industry k in the year 2000. All explanatory variables take the form of interactions between industry intensities and country endowments which are denoted in lower case and upper case letters, respectively. The interaction terms allow testing whether countries export relatively more in industries that intensively use their abundant production factors. The right hand side of equation (1) includes our variables of main interest, i.e. the quality of institutions ($q_k Q_i$) and the quality of infrastructure ($t_k T_i$), as well as the traditional comparative advantage variables capital ($k_k K_i$) and human capital ($h_k H$). Fixed effects γ_i and μ_k control for country- and industry-specific effects, respectively.

In addition, we test the hypothesis that the quality of institutions and a country's ability to export with short time delays may be more important factors in determining the comparative advantage patterns of trade in intermediate than in consumption goods by estimating the following equation:

[39] Evans and Harrigan (2005) use product-level information for an U.S. retailer to show that the retailer sources those clothes from nearby countries that are ordered more than once par selling season and hence require timely delivery.

$$X_{ikg} = \beta_0 + \beta_1 k_k K_i + \beta_2 h_k H_i + \beta_3 q_k Q_i + \beta_4 q_k Q_i I_g + \beta_5 t_k T_i + \beta_6 t_k T_i I_g + \gamma_i + \mu_k + \varepsilon_{ikg} \quad (2)$$

where X_{ikg} are pooled exports with g denoting either exports of intermediates or exports of other goods. To test whether comparative advantage patterns are significantly different for intermediates, we interact the quality of institutions variable and the export timeliness variable with the intermediate goods dummy I_k that equals 1 if X_{ikg} are intermediate exports and 0 if X_{ikg} are other exports.

By using country and industry fixed effects in all regressions, endogeneity concerns are limited. Nevertheless, one might argue that for instance trade (specialisation) in institutional-intensive sectors could stimulate institutional reform or that trade in time-sensitive sectors could foster investments in transport infrastructure. We address potential endogeneity by applying instrumental variables (IV) regressions. IV regressions and other robustness checks are presented in the second part of Section 3.5.

3.4 Data

3.4.1 Trade Data - Distinguishing between Intermediate and Consumption Goods

In the following we describe main variables and their source. A more detailed description of all data and correspondences is given in the data description in Appendix 3.A. Our dependent variable distinguishes exports in intermediates and exports in consumption goods. We classify the two types of trade using the UN Broad Economic Categories (BEC) classification. The BEC classification groups products into three categories of goods according to their main end use, i.e. intermediate, consumption and capital goods[40].

Exports data at the SITC Rev. 3 5-digit level are from the OECD/UN International Trade Commodity Statistics (ITCS) database. We use the UN SITC Rev.3 to BEC correspondence to identify intermediate, consumption, capital and not classified goods at the 5-digit SITC Rev. 3 level. Then we use our SITC Rev.3 to NAICS 1997 correspondence to aggregate exports by BEC category to the 6-digit NAICS industry level.

[40] A further residual category is that of not classified goods including for example passenger motor vehicles. Passenger motor vehicles are not classified by BEC because they are used as capital goods when purchased by a company to run its businesses, whereas they are used as consumption goods when bought by private households.

Table 3.1 shows that intermediate goods are most important in world trade accounting for 57.6 percent of exports in 2000. Consumption and capital goods have similar shares in total trade with about 18 percent each. Furthermore, intermediates are not only most important in terms of trade volume but also regarding the number of traded products. The BEC classification identifies 1,873 out of 3,053 products as intermediates. Recently, other studies have used the BEC classification to study the patterns of trade in intermediate goods (Bergstrand and Egger, 2010; Miroudot et al. 2009). Our approach, however, is conceptually different from these studies, as they use the gravity model to study the volume of trade, while we focus on the pattern of trade.

Table 3.1: Importance of intermediate, consumption and capital goods in world trade

	Number of SITC Rev.3 lines	Exports in Mill. USD	Total exports (%)
Total	3,053	5,900,952.0	100.0%
Intermediate	1,873	3,397,270.5	57.6%
Consumption	698	1,096,182.5	18.6%
Capital	468	1,082,342.4	18.3%
Not classified	14	325,156.7	5.5%

3.4.2 Industry Intensities and Country Endowments

Capital intensity k_k and skilled labour intensity h_k of 6-digit NAICS industries for the year 2000 are taken from the U.S. NBER-CES Manufacturing Industry Database. Capital intensity k_k is measured by the natural log of the total real capital stock per worker in industry k. Skilled labour intensity h_k is measured by the share of non-production workers in total employment of industry k. In contrast to trade data, it is not possible to differentiate capital and skilled labour intensity by intermediates and other types of goods. Institutional intensity q_k of NAICS industry k is measured as the share of not reference priced SITC Rev.3 products in the industry. To construct this variable we use the classification of Rauch (1999), which groups goods into goods traded on an organised exchange, reference priced goods and not reference priced goods. Our measure differs from that of Nunn (2007), who aggregates the classified goods to the industry level using input shares from U.S. input output tables. In contrast to Nunn (2007), we are especially interested in the differences between intermediate and final goods and employ hence the BEC classification to calculate separate institutional intensities for intermediate and final goods of an industry. Timeliness t_k of NAICS industry k is measured by the share of US imports shipped by air in the year 2000. As in the case of institutional intensity, our timeliness variable varies within a NAICS industry by type of good.

Country endowments of capital K_i and human capital H_i are measured by the natural log of capital stock per worker and the natural log of human capital per worker for the year 1988 taken from Hall and Jones (1999). In our benchmark specification, a country's quality of institutions Q_i is measured by the rule of law index from the World Bank Worldwide Governance Indicators 2009. A country's ability to export timely is measured by the quality of transport infrastructure T_i as captured by the infrastructure component of the World Bank Logistics Performance Index. Quality of infrastructure matters because it is an important determinant of the length of time to export and of the certainty of delivery, beyond being an important determinant of the financial dimension of trade costs. To test the robustness of results, we also use the time to enforce contracts and the cost to enforce contracts from the World Bank Doing Business Indicators as alternative measures for the quality of institutions. As an additional measure for a country's ability to deliver on time, we use the time to export from World Bank Doing Business and, following Limão and Venables (2001), we construct an index of the quality of transport infrastructure. This is calculated as the average of the deviations from the sample mean of the following four variables: (i) the percentage of paved road; (ii) the density of the rail network, both taken from the World Development Indicators 2008; (iii) the number of airports with paved runways over 3,047 meters – obtained from the CIA Factbook; and (iv) a port efficiency index (ranging between 1 and 10) taken from the IMD World Competitiveness year book.

Summary statistics of factor endowments and factor intensities are provided in Tables 3.2-3.4 in Appendix 3.B. Table 3.3 shows that timeliness is on average higher for intermediates than for consumption goods with 22 percent of U.S. intermediate imports shipped by air on average. Regarding institutional intensity, Table 3.3 indicates that the share of not reference priced products in an industry is on average 78 percent in the case of consumption goods and 65 percent in the case of intermediate goods. Table 3.4 shows the correlation between factor intensities and the share of intermediates in industry exports. This correlation is positive and significant for capital intensity, not significant for skilled labour intensity, and negative and significant for both institutional intensity and timeliness.

Tables 3.5-3.8 in Appendix 3.B report the top and bottom 15 industries in terms of capital intensity, skilled labour intensity and timeliness as well as the corresponding export shares of intermediate goods.[41] While the most capital intensive industries export mainly intermediates, the least capital intensive industries do generally not export intermediates but are rather final goods

[41] For institutional intensity a ranking of industries is not presented since more than 15 industries have an intensity of either 0 or 1. For timeliness two tables are presented since it is calculated separately for intermediates and other goods.

industries. On the other hand, intermediate goods are produced by both skilled labour-scarce and skilled labour intensive industries. However, the most skilled labour intensive industries are capital goods industries.

3.5 Results

3.5.1 Comparative Advantage in Intermediate and Final Goods Trade

Table 3.9 reports the OLS estimations of equation 1 for three sets of regressions. Columns A.1-A.3 show the results of the regression for total trade, columns B.1-B.3 report the results for trade in intermediate goods, and columns C.1-C.3 provide the results for trade in consumption goods. All regressions control for the traditional factors of comparative advantage: capital and skilled labour. For each dependent variable, we provide in the first column the estimates for traditional sources of comparative advantage adding only the interaction term for institutional quality, in the second column we add the interaction term for timely delivery and in the third column we simultaneously control for all the traditional and new sources of comparative advantage as specified in equation 1. All coefficients are beta standardised so that their size can be compared.

In line with existing literature, we find that the quality of institution is an important determinant of total trade patterns (Set A). That is, countries with a good rule of law specialise in institutional-intensive industries. Similarly, when we include timely delivery interaction we find that countries with high quality of infrastructure have a comparative advantage in time-sensitive industries. Comparing the size of coefficients, we see that both the quality of institutions and transport infrastructure are more important sources of comparative advantage than human capital.[42] Importantly, we find that the impact of timely delivery on the patterns of trade is larger than for institutions suggesting that time management explains a higher share of trade.

The importance of quality of institutions and timely delivery in explaining trade patterns is also confirmed when we run the regression separately for intermediate and consumption goods. Interestingly, while the impact of institutional quality is similar on exports of intermediates (columns B.1-B.3) and of consumption goods (columns C.1-C.3), timely delivery is found to be particularly important for exports of intermediate goods confirming theoretical expectations. Another result worth mentioning is that our findings suggest that the standard result in the literature (see Nunn, 2007 and Levchenko, 2007) that the traditional sources of comparative advantage do not explain much of trade is driven by trade in final consumption. In fact, skilled

[42] This confirms Nunn (2007), who finds that institutions are more important for comparative advantage than traditional sources.

labour appears to be a very important factor in intermediate goods exports, while it does not show to be significant in final goods trade.

Table 3.9: The determinants of comparative advantage in intermediates and final goods trade

	Total trade	Total trade	Total trade	Intermediate	Intermediate	Intermediate	Consumption	Consumption	Consumption
	A.1	A.2	A.3	B.1	B.2	B.3	C.1	C.2	C.3
qxQ (institutions)	0.187***		0.163***	0.247***		0.207***	0.226***		0.236***
	(14.318)		(12.081)	(15.820)		(12.621)	(9.878)		(10.036)
txT (infrastructure)		0.225***	0.184***		0.303***	0.244***		0.077***	0.047**
		(16.186)	(12.910)		(16.947)	(12.443)		(3.274)	(1.998)
kxK (capital)	0.247***	0.102*	0.372***	0.245***	-0.002	0.371***	0.180*	-0.106	0.223**
	(4.136)	(1.842)	(5.984)	(3.341)	(-0.033)	(4.887)	(1.871)	(-1.156)	(2.161)
hxH (human capital)	0.096***	0.057***	0.048***	0.144***	0.089***	0.077***	0.016	0.041*	0.017
	(9.036)	(4.819)	(4.052)	(10.120)	(5.904)	(4.853)	(0.770)	(1.888)	(0.753)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.752	0.752	0.754	0.748	0.75	0.75	0.722	0.716	0.72
Numb. of observations	29,126	28,343	27,153	18,993	19,600	17,838	11,252	10,971	10,414
Numb. of countries	103	95	95	103	95	95	103	95	95
Numb. of industries	343	359	342	241	265	241	136	142	135

Notes: The dependent variable is the natural log of exports in industry k by country i to the World. Coefficients are beta standardized and t-values for robust standard errors are reported in brackets. * Significant at 10%; ** at 5%; *** at 1%.

3.5.2 Differences in Comparative Advantage between Intermediate and Final Goods

Next, we test whether there are significant differences in the sources of comparative advantage between intermediate and final goods by estimating equation (2). Table 3.10 reports the results of the respective OLS regressions. This time, we pool export flows of intermediates and other types of goods and test the significance of the variables interacted with the intermediate good trade dummy: a dummy that is one for exports of intermediates in industry k and zero for exports of other goods types in industry k. In creating these interaction terms we center variables at the sample mean in order to facilitate the interpretation of results[43]. By doing so, the coefficient of the intermediate dummy is estimated at the mean of the continuous interaction terms rather than at the hypothetical value of zero.

Columns A.1-A.3 report results when intermediate exports and all other exports[44] are pooled, while columns B.1-B.3 show results when intermediate exports are pooled with consumption exports only. Contrary to expectations, the interaction of intermediates and institutions is not significant indicating that institutions matter to a similar extent for exports of intermediates and other types of goods. This result is a bit surprising since we expected the hold-up problem to be stronger in the case of intermediates than in the case of consumption goods so that a country's rule of law would be a more important source of comparative advantage for exports of intermediates.

As expected, instead, the coefficient of the interaction between the dummy denoting intermediates and the comparative advantage variable for timeliness is significant and positive. Hence, countries with a good quality of infrastructure specialise in exports of time-sensitive goods, particularly in time-sensitive intermediate goods. This confirms our theoretical prediction that timeliness is more crucial to the success of countries to integrate into intermediate stages of global production networks than to serve final consumers.

Columns A.3 and B.3 include additionally interaction terms of the intermediate dummy with capital and human capital interactions. The positive sign of interactions terms in column (6) indicate that comparative advantage in capital and human capital might be more pronounced for intermediate exports than for consumption exports. However, both coefficients are not statistically significant. One possible explanation is that the industry intensities of capital and skilled labour do not vary for intermediates and consumption goods. Hence, for industries

[43] We first center industry intensities and country endowments before interacting them. Then, we center the resulting interaction terms at their means before interacting them with the intermediate goods dummies.
[44] This is the sum of consumption goods exports, capital goods exports and exports of goods which are not classified by BEC.

exporting both intermediates and consumption goods, we have to assume that the same capital and skilled labour intensity are used in the production process of both good types.

Table 3.10: Testing for differences in the determinants of comparative advantage for intermediate goods

	Intermediate versus all other exports			Intermediate versus consumption exports		
	A.1	A.2	A.3	B.1	B.2	B.3
qxQ (institutions)	0.060***	0.063***	0.055***	0.064***	0.069***	0.065***
	(15.465)	(10.175)	(8.683)	(15.098)	(9.710)	(8.765)
qxQxI		-0.005	0.005		-0.008	-0.003
		(-0.902)	(0.790)		(-1.198)	(-0.422)
txT (infrastructure)	0.043***	0.034***	0.030***	0.045***	0.017***	0.017***
	(12.480)	(7.028)	(5.987)	(11.706)	(2.791)	(2.738)
txTxI		0.013***	0.017***		0.037***	0.036***
		(2.756)	(3.402)		(6.018)	(5.518)
kxK (capital)	0.019***	0.018***	-0.001	0.026***	0.026***	0.018**
	(4.726)	(4.652)	(-0.114)	(5.972)	(5.953)	(2.445)
kxKxI			0.026***			0.011
			(4.233)			(1.604)
hxH (human capital)	0.017***	0.017***	0.022***	0.018***	0.016***	0.009
	(5.194)	(5.255)	(4.941)	(4.724)	(4.299)	(1.383)
hxHxI			-0.005			0.009
			(-1.238)			(1.369)
I (intermediate dummy)	-0.076***	-0.077***	-0.076***	-0.01	-0.011*	-0.011*
	(-15.832)	(-15.875)	(-15.855)	(-1.627)	(-1.659)	(-1.663)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.709	0.709	0.709	0.691	0.691	0.691
Numb. of observations	33,743	33,743	33,743	28,252	28,252	28,252
Numb. of countries	95	95	95	95	95	95
Numb. of industries	342	342	342	309	309	309

Notes: The dependent variable is the natural log of intermediate or all other (consumption) exports in industry k by country i to the World. Coefficients are beta standardized and t-values for robust standard errors are reported in brackets. * Significant at 10%; ** at 5%; *** at 1%.

3.5.3 Robustness: Alternative Measures for Institutions and Transport Infrastructure

To test the robustness of our results, we estimate equation (2) using alternative measures of country endowments regarding institutional quality and timely delivery. Table 3.11 provides the results of these estimates and shows that our previous findings are robust to the use of alternative measures. In particular, we find that coefficient for the quality of institution is significant and of the expected sign also when the quality of institutions is proxied by the time (columns A.3 and B.3) or the cost required to enforce a contract (columns A.4 and B.4). In addition, timely delivery is an significant determinant of comparative advantage also when it is measured by the days required to export (columns A.1 and B.1) or by an index of transport infrastructure – calculated as an average of the quality of rail, road, air and port infrastructure (columns A.2 and B.2).

Furthermore, these regressions confirm the greater importance of timeliness for exports of intermediates than for exports of final and other goods. In fact, while the interaction term including the intermediate good dummy is in general not significant for the variables that denote the quality of institutions, it is significant and of the same sign as the non-interacted term for the variables that denote a country's ability to meet requests for timely delivery.

Table 3.11: Using alternative measures of country endowments

	Intermediate versus all other exports				Intermediate versus consumption exports			
	A.1	A.2	A.3	A.4	B.1	B.2	B.3	B.4
qxQ (institutions)	0.061***	0.058***			0.066***	0.061***		
	(10.131)	(9.842)			(9.500)	(9.059)		
qxQxI	-0.005	-0.002			-0.005	-0.001		
	(-0.780)	(-0.354)			(-0.831)	(-0.170)		
qxQ (time to enforce contract)			-0.025***				-0.021***	
			(-4.397)				(-3.297)	
d_int_q_rauch_time			0.005				0.001	
			(0.838)				(0.122)	
qxQ2 (cost to enforce contract)				-0.039***				-0.051***
				(-6.270)				(-7.008)
qxQ2xI				0.008				0.016**
				(1.368)				(2.327)
txT (infrastructure)			0.036***	0.036***			0.022***	0.020***
			(7.350)	(7.356)			(3.312)	(3.059)
txTxI			0.019***	0.019***			0.041***	0.043***
			(4.122)	(4.138)			(6.521)	(6.797)
txT2 (time to export)	-0.035***				-0.019***			
	(-7.730)				(-3.123)			
txT2xI	-0.007				-0.027***			
	(-1.591)				(-4.356)			
txT3 (road,rail,port,air)		0.039***				0.032***		
		(8.863)				(5.120)		
txT3xI		0.011**				0.022***		
		(2.305)				(3.615)		
kxK (capital)	0.017***	0.015***	-0.001	0.004	0.025***	0.023***	0.005	0.012***
	(4.497)	(4.089)	(-0.239)	(1.109)	(5.738)	(5.379)	(1.257)	(2.939)
hxH (human capital)	0.017***	0.019***	0.022***	0.020***	0.016***	0.019***	0.020***	0.018***
	(5.247)	(6.415)	(6.544)	(6.121)	(4.538)	(5.384)	(5.199)	(4.859)
I (intermediate dummy)	-0.078***	-0.081***	-0.075***	-0.075***	-0.014**	-0.016***	-0.01	-0.01
	(-16.464)	(-17.295)	(-15.481)	(-15.487)	(-2.277)	(-2.588)	(-1.555)	(-1.554)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.712	0.711	0.708	0.708	0.695	0.694	0.69	0.691
Numb. of observations	34,868	36,023	33,352	33,352	29,196	30,158	27,925	27,925
Numb. of countries	99	102	93	93	99	102	93	93
Numb. of industries	342	342	342	342	309	309	309	309

Notes: The dependent variable is the natural log of intermediate or all other (consumption) exports in industry k by country i to the World. Coefficients are beta standardized and t-values for robust standard errors are reported in brackets. * Significant at 10%; ** at 5%; *** at 1%.

3.5.4 Robustness: Homogeneous Industries

As a further robustness check, we run the regressions for the subsample of "homogeneous" industries, i.e. industries which produce either only intermediates or only consumption goods. The reason for this further test is to make sure that our results are not biased by the fact that the variables for an industry's capital and skill labour intensity are the same across types of goods. While our measures of timeliness and institutional intensity vary for intermediates and consumption goods within the same industry, capital and skilled labour intensity cannot be differentiated by type of good since they are measured directly at the industry level. By looking

at the subsample of "intermediates-only" and "consumption goods-only" industries, we can be sure that these intensities really correspond to a certain good type. Our main result is confirmed, namely that timeliness in exporting has a larger impact on the export pattern of intermediate goods than of final goods (columns B.1 and B.2). Two further results reported in Table 3.12 are worth mentioning. First, the coefficient of the human capital interaction has a negative sign for exports of consumption goods (column A.2). This result complements findings of Table 3.9 where human capital had no significant effect in two out of three regressions (columns C.1 and C.3). Hence, it seems that while human capital tends to be important for intermediates it does not constitute a source of comparative advantage for trade in consumption goods. Furthermore, for this subsample we find that in institution-intensive sectors the quality of institutions increases exports of intermediates significantly more than exports of final goods.

Table 3.12: Comparative advantage patterns for homogenous industries

	Separate Regressions		Pooled Regressions	
	Intermediate	Consumption	Intermediate versus Consumption	
	A.1	A.2	B.1	B.2
qxQ (institutions)	0.137***	0.092***	0.019**	0.022**
	(6.655)	(2.586)	(1.986)	(2.248)
qxQxI			0.022**	0.018*
			(2.413)	(1.828)
txT (infrastructure)	0.190***	0.056*	0.025***	0.029***
	(7.431)	(1.743)	(3.411)	(3.834)
txTxI			0.022***	0.017**
			(2.990)	(2.236)
kxK (capital)	0.364***	0.491***	0.037***	0.047***
	(3.498)	(3.409)	(6.763)	(5.170)
kxKxI				-0.012
				(-1.300)
hxH (human capital)	0.055***	-0.091***	0.007*	-0.001
	(2.594)	(-3.097)	(1.682)	(-0.198)
hxHxI				0.011*
				(1.692)
I (intermediate dummy)			-0.057***	-0.057***
			(-4.817)	(-4.814)
Country fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
R-squared	0.742	0.717	0.728	0.728
Numb. of observations	10,197	4,924	16,889	16,889
Numb. of countries	95	95	95	95
Numb. of industries	134	62	205	205

Notes: In separate regressions, the dependent variable is either the natural log of intermediate exports or of consumption exports. In pooled regressions, the dependent variable is the natural log of intermediate or consumption exports. Regressions are run only for homogeneous industries, i.e. industries exporting either only intermediate or only consumption goods. Coefficients are beta standardized and t-values for robust standard errors are reported in brackets. * Significant at 10%; ** at 5%; *** at 1%.

3.5.5 Robustness: Endogeneity

One possible concern to our estimation strategy is the potential endogeneity of the quality of institutions or transport infrastructure of a country. OLS regressions may capture only the correlation between these variables and trade but not necessarily causality. For instance, better infrastructure might not only lead to higher exports in time-sensitive sectors, but higher exports in these sectors themselves might trigger government spending on infrastructure. However, the use of country and industry fixed effects and the fact that time-sensitive sectors only constitute a subset of trade flows, makes us confident that the influence of exports in time-sensitive sectors on infrastructure investment is limited. Nevertheless, we instrument for the quality of infrastructure following Djankov et al. (2010) and run the regressions for a subsample of landlocked countries

using the average quality of infrastructure as well as the average timeliness in exporting of neighbouring countries as instrumental variables. The idea is that while exports of a landlocked county might affect its infrastructure, it will not affect the investment in infrastructure of its neighbours. However, the infrastructure of its neighbours will affect its ability to export timely since exports will have to pass these countries and are hence dependent of the quality of infrastructure there. Regarding the quality of institutions, we follow Nunn (2007) and use legal origins as instruments. It makes intuitive sense to assume that the different legal origins of countries, i.e. British, French, German, Social or Scandinavian, are reflected in today's quality of institutions of countries but that legal origins themselves are not affected by comparative advantage in 2000.

Table 3.13 provides regression results when the transport infrastructure of landlocked countries is instrumented using neighbour countries averages for the quality of transport infrastructure and the timeliness in exporting. Since we only look at the case of landlocked countries, the number of countries left in the regressions shrinks to 13. Results confirm that if countries improve their transport infrastructure, they will indeed experience an increase in exports in time-sensitive sectors. Further support is given by the Sargan overidentification that does not reject the validity of our instruments. [45] The small sample size probably explains why the traditional comparative advantage interactions for capital and human capital are not significant anymore or have not the expected sign.

[45] We have also experimented using the same instruments for the entire sample of countries. While coefficients of the instrumented variable are positively signed and are significant, the overidentification test rejects the validity of instruments.

Table 3.13: 2SLS IV regressions instrumenting for the quality of transport infrastructure

	Total trade	Total trade	Intermediate	Intermediate	Consumption	Consumption
	A.1	A.2	B.1	B.2	C.1	C.2
qxQ (institutions)		0.173***		0.256***		0.271***
		(5.761)		(6.626)		(5.236)
txT (infrastructure)	0.188***	0.160***	0.263***	0.211***	0.121**	0.111**
	(5.806)	(4.721)	(6.383)	(4.619)	(2.257)	(2.043)
kxK (capital)	-0.480***	-0.106	-0.546***	0.089	-0.951***	-0.467*
	(-3.782)	(-0.734)	(-3.410)	(0.476)	(-4.383)	(-1.906)
hxH (human capital)	0.013	0	0.027	0.004	0.062	0.024
	(0.462)	(-0.012)	(0.672)	(0.085)	(1.230)	(0.476)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.771	0.772	0.773	0.772	0.742	0.75
Numb. of observations	3,383	3,249	2,196	1,996	1,299	1,232
Numb. of countries	13	13	13	13	13	13
Numb. of industries	358	342	265	241	142	135
Over-id test (p-value)	0.167	0.139	0.522	0.463	0.24	0.308

Notes: The dependent variable is the natural log of exports in industry k by country i to the World. txT is instrument using two txIV interaction terms where the instruments (IV) are the average T of neighbouring countries and the neighbour average of the timeliness component of the LPI index. Reported are the beta standardized coefficients of the second stage IV regression with t-values shown in brackets. * Significant at 10%; ** at 5%; *** at 1%.

Table 3.14 reports results when the quality of institutions is instrumented using legal origin dummies. Coefficients of the institution interaction are all positive and significant. However, as in the case of Nunn (2007) the Sargan overidentification test rejects the validity of our instruments and the coefficient of the instrumented institution interaction is larger than in the OLS regression in Table 3.9. The estimated coefficient should however be smaller in the case of a simultaneous relationship as the instruments should only explain the direction from institutions to trade.

Table 3.14: 2SLS IV regressions instrumenting for the quality of institutions

	Total trade	Total trade	Intermediate	Intermediate	Consumption	Consumption
	A.1	A.2	B.1	B.2	C.1	C.2
qxQ (institutions)	0.256***	0.230***	0.295***	0.267***	0.450***	0.447***
	(11.103)	(9.376)	(10.361)	(8.529)	(11.125)	(10.604)
txT (infrastructure)		0.170***		0.226***		0.026
		(11.771)		(11.155)		(1.098)
kxK (capital)	0.374***	0.486***	0.338***	0.472***	0.572***	0.580***
	(6.039)	(7.692)	(4.284)	(5.914)	(5.550)	(5.406)
hxH (human capital)	0.089***	0.044***	0.138***	0.075***	-0.013	-0.008
	(8.230)	(3.843)	(9.377)	(4.792)	(-0.676)	(-0.402)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.751	0.753	0.747	0.749	0.719	0.717
Numb. of observations	29,126	27,153	18,993	17,838	11,252	10,414
Numb. of countries	103	95	103	95	103	95
Numb. of industries	343	342	241	241	136	135
Over-id test (p-value)	0	0	0	0	0	0

Notes: The dependent variable is the natural log of exports in industry k by country i to the World. qxQ is instrument using four txIV interaction terms where the instruments (IV) are dummies for british, french, german, social and scandinavian (omitted) legal origin. Reported are the beta standardized coefficients of the second stage IV regression with t-values shown in brackets. * Significant at 10%; ** at 5%; *** at 1%.

3.6 Conclusions

Recent literature on production networks has emphasised the importance of a country's ability to enforce a contract and its ability to meet strict delivery times. This paper complements existing studies that show that the quality of institutions and of transport infrastructure provide a comparative advantage in exporting institution-intensive and time-sensitive goods, respectively.

We contribute to the literature by extending these results to trade in intermediates. In particular, we find that the hold-up problem and timeliness are both very more important determinants of the patterns of trade and this is true both for trade in general and for trade in intermediates. However, two of our results underline the importance of the quality of transport infrastructure, i.e. timeliness in exporting, for the pattern of trade in intermediate goods. First, we find that the impact of transport infrastructure on the comparative advantage pattern of trade in intermediates is larger than the respective impact of institutional quality. Second, comparing trade in intermediates and trade in final goods, we find that the quality of transport infrastructure is more important for comparative advantage in intermediate goods than in final goods. This result suggests that timeliness is more crucial to the success of countries to integrate into intermediate stages of global production networks than to serve final consumers.

These results have important policy implications as they emphasise the importance of timeliness for the just-in-time needs of production networks and help explain why many countries are left out of production networks. By providing a more detailed understanding of the role of institutions and transport infrastructure for comparative advantage patterns of trade, our results may also provide guidance in the evaluation of possible gains from aid for trade.

Appendix 3.A: Data Description

Exports data at the SITC Rev. 3 5-digit level are from the OECD/UN International Trade Commodity Statistics (ITCS) database. Using the correspondence table from Feenstra et al. (2002), we create a SITC Rev.3 to NAICS 1997 correspondence. Thereby, we follow Nunn (2007) and create a unique mapping of 5-digit SITC Rev.3 products to 6-digit NAICS 1997 industries.

Hence, we use the UN SITC Rev.3 to BEC correspondence to identify intermediate, consumption, capital and not classified goods at the 5-digit SITC Rev. 3 level. Then we use our SITC Rev.3 to NAICS 1997 correspondence to aggregate exports by BEC category to the 6-digit NAICS 1997 industry level.

Capital intensity k_k and skilled labour intensity h_k of 6-digit NAICS industries for the year 2000 are taken from the NBER-CES Manufacturing Industry Database. Capital intensity k_k is measured by the natural log of the total real capital stock per worker in industry k. Skilled labour intensity h_k is measured by the share of non-production workers in total employment of industry k. Differently to trade data, it is not possible to differentiate capital and skilled labour intensity by intermediates and other types of goods.

Institutional intensity q_k of NAICS industry k is measured as the share of not reference priced SITC Rev.3 products in the industry. To construct this variable we use the classification of Rauch (1999), which groups goods into goods traded on an organised exchange, reference priced goods and not reference priced goods. Since the Rauch classification is based on SITC Rev. 2, we first built a SITC Rev.2 to SITC Rev.3 correspondence and then apply our SITC Rev.3 to NAICS 1997 correspondence. Both correspondences are constructed using the correspondence table of Feenstra (2002). However, while SITC Rev.3 lines are uniquely assigned to NAICS industries, the correspondence is not unique from SITC Rev. 2 to SITC Rev.3, i.e. one SITC Rev. 2 line can be assigned to several SITC Rev.3 lines. The merging of the Rauch classification with the correspondence resulted in 688 classified SITC Rev.2 products being assigned to 2,890 SITC Rev.3 categories. Note that this measure is significantly different from that built by Nunn (2007) that aggregates the classified goods to the industry level using input shares from U.S. input output tables, without distinguishing inputs and products consumed by private households. Since we are especially interested in the differences between intermediates and final goods, we use the

BEC classification to calculate separate institutional intensities for intermediates and consumption goods of an industry.

Timeliness t_k of NAICS industry k is measured by the share of US imports shipped by air in the year 2000. Data on US imports and shipping mode at the HS10 digit level are collected by the U.S. Census Bureau and are taken from the homepage of Peter Schott. In constructing this measure, bilateral data are first aggregated to total U.S. imports at the HS10 digit level. Using the unique HS10 to NAICS 1997 correspondence from Feenstra (2002), the measure of timeliness is then calculated as the simple average of HS10 air transport shares in NAICS industry k. As in the case of institutional intensity, timeliness varies within an NAICS industry by type of good, i.e. intermediate, consumption and capital goods. We used the UN HS1996 to BEC correspondence to assign 6-digit HS products to BEC categories. Hence, disaggregated HS10 products are assumed to be the same BEC type of good as the corresponding more aggregate HS6 product.

Country endowments of capital K_i and human capital H_i are measured by the natural log of capital stock per worker and the natural log of human capital per worker for the year 1988 taken from Hall and Jones (1999).[46] In our benchmark specification, a country's quality of institutions Q_i is measured by the rule of law index from the World Bank Worldwide Governance Indicators 2009. A country's ability to export fast is measured by the quality of transport infrastructure T_i as captured by the infrastructure component of the World Bank Logistics Performance Index. Quality of infrastructure matters because it is an important determinant of the length of time to export and of the certainty of delivery, beyond being an important determinant of the financial dimension of trade costs. To test the robustness of results, we also use the time to enforce contracts and the cost to enforce contracts from the World Bank Doing Business Indicators as alternative measures for the quality of institutions. As an additional proxy for a country's ability to deliver on time, we use the time to export from World Bank Doing Business and, following Limão and Venables (2001), we construct an index of the quality of transport infrastructure. This is calculated as the average of the deviations from the sample mean of the following four variables: (i) the percentage of paved road; (ii) the density of the rail network - both taken from the World Development Indicators 2008-; (iii) the number of airports with paved runways over 3,047 meters – obtained from the CIA Fact book; and (iv) a port efficiency index (ranging between 1 and 10) taken from the IMD World Competitiveness year book.

[46] The data is accessible at http://www.stanford.edu/%7Echadj/HallJones400.asc. Previous papers that have used these data include for example Romalis (2004), Levchenko (2007) and Bernard, Jensen, Redding and Schott (2010).

Appendix 3.B: Figures and Tables

Figure 3.1: Share of intermediate and consumption goods in total exports of countries in 2000

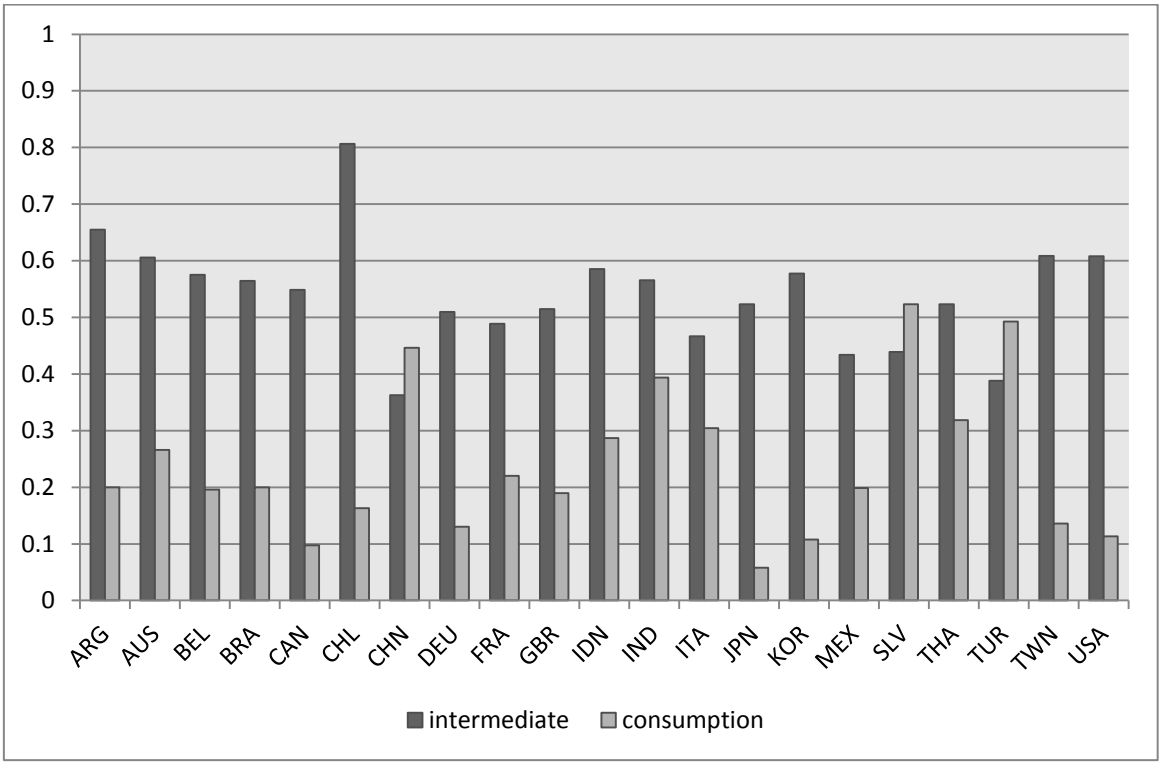

Figure 3.2: Shares of intermediates in exports of office machinery (NAICS 333313) in 2000

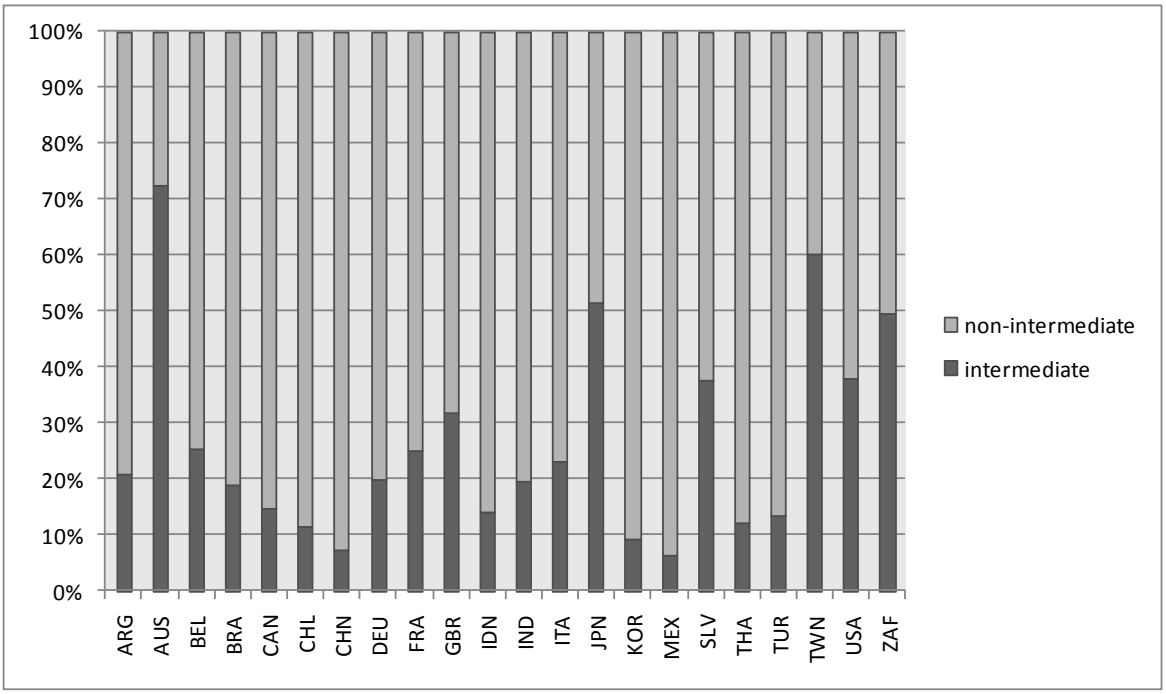

Table 3.2: Summary statistics of country endowments

	Obs	Mean	Std. Dev.	Min	Max
Rule of Law	103	2.650	1.002	1.043	4.425
ln(K/L)	103	9.422	1.504	5.763	11.589
ln(H/L)	103	0.613	0.291	0.072	1.215
LPI Infrastructure	95	2.779	0.746	1.400	4.290
LPI Timeliness	95	3.340	0.651	2.000	4.530

Table 3.3: Summary statistics of industry intensities

	Obs.	Mean	Std. Dev.	Min	Max
capital intensity	360	11.491	0.879	9.547	14.299
skilled labor intensity	360	0.286	0.114	0.087	0.682
institutional intensity int.	241	0.649	0.433	0	1
institutional intensity con.	136	0.778	0.403	0	1
timeliness int.	265	0.217	0.217	0	0.901
timeliness con.	142	0.187	0.212	0	0.968

Table 3.4: Pairwise correlations between industry intensities and the share of intermediates in industry exports

	Intermediate export share
capital int.	0.343*
skilled labor int.	-0.080
institutional int. interm.	-0.199*
timeliness interm.	-0.311*

Note: *Significant at 5%

Table 3.5: Capital intensity - bottom and top 15 industries and export share of intermediates

Capital intensity - bottom 15 industries

NAICS	*Industry*	*Capital int.*	*Export share - intermediates*
315991	Hats And Cap	9.55	0.03
315993	Men S & Boys Neckwear	9.60	0.00
315292	Fur And Leather Apparel	9.62	0.00
315999	Other Apparel Accessories	9.72	0.02
314121	Curtains And Draperies	9.74	0.00
316993	Personal Leather Goods (Except Women'S Handbags And Purses)	9.78	0.00
315239	Women'S And Girls' Other Outerwear	9.85	0.00
339911	Jewelry (Except Costume)	9.89	0.00
337121	Upholstered Household Furniture	9.90	0.00
314912	Canvas And Related Products	10.02	0.27
314911	Textile Sacks And Bags	10.03	1.00
339950	Signs	10.05	1.00
316999	All Other Articles Of Leather	10.05	0.02
336214	Transportation Equipment, Nesoi Including Trailers And Campers	10.10	0.00
336612	Boats	10.12	0.00

Capital intensity - top 15 industries

NAICS	*Industry*	*Capital int.*	*Export share - intermediates*
311223	Other Oilseed Products	13.28	0.74
325312	Phosphatic Fertilizers	13.29	1.00
325182	Carbon Black	13.31	1.00
325181	Alkalies And Chlorine	13.39	1.00
325193	Ethyl Alcohols	13.41	1.00
311213	Malts	13.59	1.00
325311	Nitrogenous Fertilizers	13.59	1.00
322122	Newsprint Mill Products	13.60	1.00
325192	Cyclic Crude And Intermediates	13.63	1.00
311221	Wet Corn Milling Products	13.69	0.90
325221	Cellulosic Organic Fibers	13.83	0.99
331411	Primary Smelting And Refining Of Copper	13.86	1.00
322110	Pulp Mill Products	14.08	1.00
324110	Petroleum Refinery Products	14.16	0.84
325110	Petrochemicals	14.30	1.00

Table 3.6: Skilled labour intensity - bottom and top 15 industries and export share of intermediates

Skilled labor intensity - bottom 15 industries

NAICS	*Industry*	*Skilled lab.*	*Export share - intermediates*
335110	Electric Lamp Bulbs And Parts	0.09	0.59
313111	Yarns	0.09	0.94
321212	Softwood Veneer And Plywood	0.10	1.00
316219	Other Footwear	0.10	0.00
311615	Poultry, Prepared Or Preserved	0.10	0.00
327213	Glass Containers	0.11	1.00
335222	Household Refrigerators And Home Freezers	0.12	0.00
311513	Cheese	0.12	0.00
313113	Threads	0.13	0.97
313210	Broadwoven Fabrics	0.13	1.00
311611	Meat Products (Except Poultry)	0.13	0.16
336111	Automobiles And Light Duty Motor Vehicles, Including Chassis	0.13	0.00
315221	Men'S And Boys' Underwear And Nightwear	0.13	0.00
321211	Hardwood Veneer And Plywood	0.13	1.00
322215	Nonfolding Sanitary Food Containers	0.13	0.00

Skilled labor intensity - top 15 industries

NAICS	*Industry*	*Skilled lab.*	*Export share - intermediates*
336411	Aircraft	0.53	0.00
334112	Computer Storage Devices	0.54	0.00
334510	Electromedical And Electrotherapeutic Apparatus	0.55	0.00
325613	Surface Active Agents	0.55	1.00
312112	Bottled Waters	0.55	0.00
334513	Instruments And Related Products For Measuring, Displaying, And Control	0.56	0.21
334515	Instruments For Measuring And Testing Electricity And Electrical Signals	0.58	0.22
333313	Office Machinery	0.59	0.36
334119	Other Computer Equipment	0.61	0.57
334210	Telephone Apparatus	0.63	0.55
334517	Irradiation Apparatus	0.63	0.49
334511	Search, Detection, Navigation, Guidance, Aeronautical, And Nautical Syste	0.64	0.10
334516	Analytical Laboratory Instruments	0.64	0.01
336414	Guided Missiles And Space Vehicles	0.65	0.00
334111	Electronic Computers	0.68	0.00

Table 3.7: Timeliness: Share of U.S. intermediate goods imports shipped by air

Timeliness intermediates goods - bottom 15 industries

NAICS	*Industry*	*Timeliness*	*Export Share*
327410	Lime And Calcined Dolomite	0.00	1.00
312130	Wines	0.00	0.01
327320	Wet, Nonrefractory Mortars And Concretes	0.00	1.00
311421	Fruits And Vegetables Preserved	0.00	0.01
312120	Malt And Beer	0.00	0.02
322130	Paperboard Mill Products	0.00	1.00
324121	Asphalt Paving Mixtures	0.00	1.00
322110	Pulp Mill Products	0.00	1.00
327310	Cements	0.00	1.00
325193	Ethyl Alcohols	0.00	1.00
311213	Malts	0.00	1.00
321113	Sawmill Products	0.00	1.00
331112	Electrometallurgical Ferroalloy Product	0.00	1.00
321213	Engineered Wood (Except Truss)	0.00	1.00
321911	Wood Windows And Doors	0.00	1.00

Timeliness intermediates goods - top 15 industries

NAICS	*Industry*	*Timeliness*	*Export Share*
334419	Other Electronic Components	0.65	0.50
325412	Pharmaceutical Preparations	0.65	0.10
334412	Printed Circuits	0.67	1.00
333993	Packaging Machinery	0.67	0.24
334415	Electronic Resistor And Parts	0.67	1.00
334511	Search, Detection, Navigation, Guidance, Aeronautical, And Nautical Systems And Instruments	0.72	0.10
325414	Biological Products (Except Diagnostic)	0.75	1.00
333314	Optical Instruments And Lenses	0.76	0.29
339115	Ophthalmic Goods	0.82	0.50
334414	Electronic Capacitors And Parts	0.83	0.07
334515	Instruments For Measuring And Testing Electricity And Electrical Signals	0.84	0.22
339914	Costume Jewelry And Novelties	0.84	0.19
339913	Jewelers' Material And Lapidary Work	0.87	1.00
334516	Analytical Laboratory Instruments	0.89	0.01
334413	Semiconductors And Related Devices	0.90	1.00

Table 3.8: Timeliness: Share of U.S. non-intermediate goods imports shipped by air

Timeliness for goods other than intermediates - bottom 15 industries

			Export Share	
NAICS	*Industry*	*Timeliness*	*Cons.*	*Capital*
321991	Mobile Homes And Trailers	0.00	1.00	0.00
336414	Guided Missiles And Space Vehicles	0.00	0.00	1.00
312112	Bottled Waters	0.00	1.00	0.00
312120	Malt And Beer	0.00	0.98	0.00
336212	Truck Trailers	0.00	0.00	1.00
311211	Flour And Other Grain Mill Products	0.00	0.08	0.00
336510	Railroad Rolling Stock	0.00	0.00	0.51
311111	Dog And Cat Foods	0.00	1.00	0.00
337124	Metal Household Furniture	0.00	0.38	0.62
311230	Breakfast Cereals	0.00	1.00	0.00
311822	Prepared Flour Mixes And Dough	0.01	1.00	0.00
312140	Distilled Liquors	0.01	0.93	0.00
337121	Upholstered Household Furniture	0.01	1.00	0.00
322291	Sanitary Paper Products	0.01	1.00	0.00
311421	Fruits And Vegetables Preserved	0.01	0.99	0.00

Timeliness for goods other than intermediates - top 15 industries

			Export Share	
NAICS	*Industry*	*Timeliness*	*Cons.*	*Capital*
334612	Prerecorded Compact Discs (Except Software), Tapes, And Records	0.60	1.00	0.00
334510	Electromedical And Electrotherapeutic Apparatus	0.61	0.18	0.82
334515	Instruments For Measuring And Testing Electricity And Electrical Signals	0.63	0.00	0.78
334518	Watches, Clocks, And Parts	0.63	0.77	0.01
334511	Search, Detection, Navigation, Guidance, Aeronautical, And Nautical Systems And Instruments	0.66	0.00	0.90
333314	Optical Instruments And Lenses	0.70	0.02	0.69
333295	Semiconductor Machinery	0.72	0.00	1.00
325221	Cellulosic Organic Fibers	0.74	0.01	0.00
334112	Computer Storage Devices	0.74	0.00	1.00
339114	Dental Equipment And Supplies	0.75	0.23	0.68
339911	Jewelry (Except Costume)	0.83	1.00	0.00
334516	Analytical Laboratory Instruments	0.84	0.00	0.99
315993	Men S & Boys Neckwear	0.84	1.00	0.00
331491	Nonferrous Metals (Except Copper And Aluminum) Rolling, Drawing, And Extruding	0.91	0.00	0.09
332618	Other Fabricated Wire Products	0.96	0.00	0.05

Note: Timeliness at the NAICS industry level has been calculated as the simple average of HS10 products which are not intermediates, i.e. consumption, capital and not classified goods.

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4 Intra-Firm Trade in Intermediate Goods

4.1 Introduction

The activities of multinational enterprises (MNEs) and the international fragmentation of production affect international trade along the two dimensions of ownership and use. First, MNE activity affects the ownership dimension of trade, i.e. the importance of intra-firm trade relative to arm's length trade. While reliable estimates on intra-firm trade for the world are not available, U.S. trade data reveal that intra-firm transactions accounted for 48 percent of U.S. imports in 2000. Second, the international fragmentation of production involves trade in goods that are *used* as intermediate inputs. Trade in intermediates accounted for 56 percent of total imports in OECD countries in 2006 (see Miroudot et al., 2009) and for 47 percent of U.S. imports in 2000. Hence, intra-firm trade and trade in intermediates are both significant in terms of volumes constituting almost 50 percent of U.S. imports each. While there has been considerable recent empirical research on both intra-firm trade (Bernard et al., 2010a; Costinot et al., 2009; Corcos et al., 2009; Nunn and Trefler, 2008) and trade in intermediates (Bergstrand and Egger, 2010; Miroudot et al., 2009; Yeats, 2001), these papers do not combine the ownership dimension with the use dimension of trade. A major contribution of this paper is that it decomposes trade flows by ownership and by main end use. This allows us to study the determinants of intra-firm trade of intermediate goods as compared to intra-firm trade of final goods bridging the gap between empirical research and theoretical models on intra-firm trade.

This paper builds on recent theoretical and empirical work in assessing the determinants of the share of intra-firm trade in total trade. Starting with Antràs (2003), theoretical trade models (Antràs and Helpman, 2004 and 2008) have emphasised the role of property rights and incomplete contracts for the international sourcing decisions of firms, i.e. whether to source intermediate inputs intra-firm through a foreign affiliate or at arm's length through an independent supplier. Property rights can mitigate the inefficiencies arising from the so-called hold-up problem which refers to the exploitation of a contracting party by its counterparty because the contract is incomplete or not enforceable while the investment undertaken is relationship-specific, i.e. worth less outside the relationship. In line with the modelling approaches undertaken by theoretical papers, we argue that the hold-up problem is more severe for intermediate goods than for final goods. Recent empirical papers such as Bernard et al. (2010a and 2010b), Nunn and Trefler (2008) and Costinot et al. (2009) test predictions of these

models. However, these papers do not distinguish between intra-firm trade in intermediate goods and intra-firm trade in final goods[47].

In our analysis, we use data from the U.S. Census Bureau on U.S. intra-firm imports in the year 2000 at the Harmonized System 6-digit (HS6) level. We combine these data with the United Nation's Broad Economic Categories (BEC) classification, which groups imported commodities according to their main end use. This allows us to distinguish intra-firm and arm's length trade in intermediate goods, capital goods and consumption goods. We find that the share of intra-firm transactions in imports is 44 percent for intermediate goods imports, 59 percent for capital goods imports and only 19 percent for consumption goods imports. In terms of empirical analysis, we follow closely Bernard et al. (2010a) by assessing the determinants of intra-firm trade at both the extensive and intensive margin and by including interactions of product and country characteristics in regressions. However, we go beyond their analysis by modelling the dependent variable(s) more accurately, namely as the share of intra-firm intermediate imports in total imports of intermediates and the share of intra-firm final imports in total imports of final goods. Putting special emphasis on the contracting environment of a country, we test for differences regarding the determinants of intra-firm trade for intermediate, capital and final consumption goods.

Our paper makes a number of contributions to the existing literature. First, by distinguishing intermediates and capital goods from consumption goods, we bring empirical analysis closer to theoretical models. Second, we show that this distinction matters as the share of intra-firm trade at the bilateral HS6 level is significantly higher for intermediate and capital goods relative to consumption goods. Third, in line with predictions from transaction cost models (Grossman and Helpman, 2003) and empirical findings (Bernard et al., 2010a), we find that a better contracting environment in a country reduces intra-firm trade relative to arm's length trade. According to the transaction cost approach, improvements in contract enforcement make the hold-up problem less severe so that the cost of outsourcing decreases relative to the cost of integration leading to a respective reduction in the share of intra-firm trade. Moreover, our results show that the contracting environment has a larger impact on the shares of intra-firm trade of intermediates and capital goods relative to consumption goods at both the extensive and the intensive margin. This finding suggests that the hold-up problem is more important for intermediates and capital goods than for consumption goods. A possible explanation for this result is that intermediates and capital goods require more relationship-specific investments of contracting parties as compared

[47] Bernard et al. (2010b) are an exception since they acknowledge this shortcoming of empirical research and confirm their results in a robustness check excluding final goods as identified by the HTS Imports Index of Sitchinava (2008).

to consumption goods. Intermediates and capital goods are often tailored to the needs of the final good producer so that both the supplier and the final good producer might undertake substantial relationship-specific investments. In other words, this indicates that intermediate products are more contract-intensive. Finally, we confirm the main prediction of Antràs (2003) that intra-firm trade is higher in capital intensive sectors and find evidence that this pattern is more pronounced for intermediate and capital goods than for consumption goods.

The rest of the paper is organised as follows. Section 4.2 describes the theoretical and empirical literature regarding the determinants of intra-firm trade and provides the motivation for the distinction of intermediate and final goods in the analysis. Section 4.3 describes the trade data used and provides an overview of intra-firm trade by type of good. Section 4.4 outlines the empirical methodology and the data used in the econometric analysis. Section 4.5 presents results and Section 4.6 concludes.

4.2 The Determinants of Intra-Firm Trade

4.2.1 Theory

In explaining the share of intra-firm trade, we draw on predictions from theoretical models that focus on the hold-up problem as the main reason for the decision of firms regarding integration or outsourcing. Thereby, we especially emphasise the role of the contracting environment and the differences between intermediate inputs and final goods. Since intra-firm trade in intermediate inputs is a direct consequence of vertical foreign direct investment (FDI), we would like to point the interested reader to the more traditional literature on vertical FDI starting with Helpman (1984) and Helpman and Krugman (1985) and to general equilibrium models of MNEs, i.e. the knowledge-capital model of Markusen (2002) and the knowledge-and-physical-capital models of Bergstrand and Egger (2007, 2010).

4.2.1.1 The Hold-Up Problem

The decision of firms to engage in either outsourcing or vertical integration is driven among other factors by the hold-up problem leading to underinvestment. The hold-up problem arises from the incompleteness or the lack of enforceability of contracts and the specificity of investments and leads to inefficiencies in a relationship between two parties. For instance, in the relationship between a final good producer and a supplier of an intermediate input, the final good producer may require the supplier to customise the inputs according to his needs. Hence, the supplier has to make a relationship-specific investment that has limited or no value outside the relationship. If

contracts are incomplete, there will be ex-post negotiations after the delivery of the input where both contracting parties try to extract as much surplus out of the relationship as possible. If the supplier has made a relationship-specific investment which is worth less outside the relationship, the final good producer has more bargaining power in the ex-post bargaining and will hold-up the supplier. Naturally, the supplier will foresee this behaviour of the final good producer and will therefore decide to keep the relationship-specificity of his investment low. Hence, the hold-up problem leads to underinvestment by the supplier. However, not only the supplier but also the final good producer might eventually face a hold-up problem if the latter makes a relationship-specific investment as well. In that case, there is a two-sided hold-up problem and both parties, final good producer and supplier, will underinvest ex-ante.

4.2.1.2 *The Property Rights Approach*

The work of Antràs (2003) introduced the property rights approach as outlined in the seminal papers of Grossman and Hart (1986) and Hart and Moore (1990) into trade theory. The assignment of property rights, i.e. ownership over the investment, gives contracting parties an outside option in the case of contract failure and hence mitigates the hold-up problem faced by either the supplier or the final good producer. According to the property-rights theory, the party which has to burden the larger share of the relationship-specific investment should obtain the property rights over the investment. The party holding the property rights has a better negotiating position in the ex-post bargaining process so that it can capture a larger share of the surplus. Therefore, the party has a greater incentive to invest ex-ante. Hence, property rights are assigned to the final good producer if his investments are more important relative to the investment of the supplier (vertical integration) or to the supplier if his share in the relationship-specific investment is relatively larger (outsourcing).

Antràs (2003) models the production of an intermediate input assuming that investment sharing is easier for capital than for labour. In this setting, the final good producer will share some of the capital-investment required for producing the intermediate input with the supplier, while the supplier will provide additionally all of the labour input. Hence, the more capital intensive the production of an intermediate, the more investment will be shared between the final good producer and the supplier, thus increasing the importance of the investment and the potential hold-up problem for the final good producer. Above a certain threshold capital intensity of the production, firms will therefore integrate in order to alleviate the hold-up problem faced by the final good producer. On the other hand, if the production of an intermediate is labour intensive, the supplier bears a greater share of the investment and will therefore be assigned the property rights. Antràs (2003) embeds this property rights approach in a factor-proportions model in which

production and trade are determined by comparative advantage in production factors: A country will specialise in the production and exports of industries which intensively use its abundant factors. Capital abundant countries will therefore export relatively more in capital intensive industries (see also Romalis, 2004). Hence, Antràs (2003) predicts that the share of intra-firm imports in total imports is higher for capital intensive industries (due to the hold-up problem) and from capital abundant countries (due to the comparative advantage pattern of trade).

While Antràs (2003) assumes that investment sharing is easier for capital than for labour, Antràs and Helpman (2004) model the relationship-specific investment of the final good producer in the form of headquarter services leading to the prediction that intra-firm trade will be higher in headquarter intensive industries. Headquarter services can be thought of as R&D investment, product design or engineering services and might be proxied by the skilled labour intensity of an industry.

4.2.1.3 The Transaction Cost Approach and the Contracting Environment

The transaction cost approach (see Coase, 1937; and Williamson, 1975, 1985, for seminal contributions) is the precursor to and closely related to the property rights approach. While the property rights approach focuses on ex-ante inefficiencies arising from incomplete contracts, the transaction cost approach is broader in scope and considers both ex-ante and ex-post inefficiencies. Ex-ante inefficiencies include underinvestment arising from the hold-up problem, while ex-post inefficiencies relate to problems arising at the termination or during the execution of the contract. While in property rights models the hold-up problem is still present also within the firm's boundaries, the transaction cost approach typically assumes that the hold-up problem is solved by vertical integration. However, it is assumed that integrated suppliers give rise to higher costs than independent ones.[48]

The contracting environment, i.e. the extent to which contracts are enforceable, is crucial in both property rights and transaction cost models since the hold-up problem arises only if contracts are incomplete, i.e. it is not possible to specify all details in a contract, or not enforceable. Lafontaine and Slade (2007) point out that most of the empirical literature testing the determinants of vertical integration disregard the fact that theoretical models assume that contracts are incomplete. If the writing of contracts is complete, there is no need for integration under both the transaction cost and the property rights approach. However, if contracts are incomplete, the transaction cost and the property rights approach may differ in their predictions regarding the impact of improvements in the contracting environment on the share of intra-firm imports.

[48] See Lafontaine and Slade (2007) and Antràs and Rossi-Hansberg (2009) for more detail regarding the comparison between the property rights and the transaction costs approach.

According to the transaction costs approach, an improvement in the contracting environment will increase outsourcing relative to vertical integration since the costs associated to ex-ante and ex-post inefficiencies decrease relative to the costs of vertical integration. For instance, Grossman and Helpman (2003) argue that a better contracting environment increases outsourcing relative to vertical integration since less investment tasks are left to the discretion of the supplier. On the other hand, in the property rights model of Antràs and Helpman (2008) an improvement in the contracting environment can increase either intra-firm or arm's length trade, depending on whether the investment undertaken by the final good producer or by the supplier benefits more. If relatively more contractual details can be specified regarding the input provided by the final good producer, then arm's length trade will increase because the final good producer is affected less by the hold-up problem. On the other hand, if the input provided by the supplier experiences an increase in contractibility, then more incentives have to be given to the final good producer and hence integration and intra-firm trade will increase.

To test for the overall effect of a country's contracting environment on intra-firm trade, we include in regressions an index measuring the country's quality of rule of law. However, as we outline below, we expect the hold-up problem to me more severe in the case of intermediates compared to consumption goods. Therefore, we go a step further and test whether an improvement in the contracting environment has a different impact on the shares of intra-firm trade of intermediate (capital) and consumption goods. This assessment of the interaction between a country's contracting environment and types of good is related to the studies of Nunn and Trefler (2008) and Bernard et al. (2010a), who investigate the interaction between the contracting environment and the relationship-specificity of industries and product contractibility respectively.

4.2.1.4 Differences between Intermediates (Capital) Goods and Consumption Goods

Both, property rights (Antràs, 2003) and transaction cost models (Grossman and Helpman, 2003) stress the importance of the hold-up problem in the relationship between a final good producer and a supplier of specialised intermediate inputs. Hence, an accurate empirical testing of these models should focus on intermediate inputs. The hold-up problem will be less relevant for consumption goods if the investments undertaken by the contracting parties are less relationship-specific and/or require less contractual details, i.e. are less contract-intensive. In the following we give two reasons why we expect this to be the case for consumption goods.

Along the lines of Antràs (2003) and Antràs and Helpman (2004), the hold-up problem regarding consumption goods might arise in the context of an U.S. MNE deciding on whether to conduct the last stage of the production process, i.e. the assembly of the final product, in-house or through

an independent supplier. The assembly stage of a good typically is technologically easy and unskilled labour intensive as compared to the production of intermediates which is typically assumed to be more capital intensive (see Markusen and Venables, 2007). If this is the case, the U.S. MNE does not need to provide much relationship-specific investment through capital or skilled labour. Hence, the U.S. importer will not be exposed much to the hold-up problem and can give incentives to the supplier by outsourcing the assembly of the final product.

Furthermore, consumption goods are to a large extent traded in a different context, namely between the firm producing it and retailers and/or wholesale traders. Hence, from the point of view of a final good producer, the decision to deliver the consumption good through either affiliated or unaffiliated distributors (forward integration) is different from the decision to source intermediate inputs from affiliated or independent suppliers (backward integration).[49] The final good producer will tailor the good to the tastes of the consumer and the relationship with the distributor is less likely to require much relationship-specific investment. Furthermore, a final good producer might not find it profitable to set up a distribution network to reach final consumers given the high fixed costs of the required investment. In Section 4.3.5, we support these arguments by providing correlations between the three good types and the index of product contractibility of Bernard et al. (2010a), which they measure as the average wholesale employment share of firms importing the product.

Following the above reasoning, we would expect the share of intra-firm trade to be higher for intermediate goods than for consumption goods. Moreover, if the hold-up problem is indeed more relevant for intermediates than for consumption goods, then we expect that an improvement in the contracting environment of a country affects more intra-firm trade in intermediates compared to intra-firm trade in consumption goods. Since capital goods are similar to intermediate goods in the sense that they are used by firms in the production process and are not targeted at consumers, we expect a similar pattern of intra-firm trade for the two types of good.

4.2.2 Empirical Findings

Given the scarcity of data on intra-firm trade, few empirical papers exist on the topic. Only recently some papers have used either firm level data (Corcos et al., 2009, Marin, 2006) or trade data on intra-firm imports from the U.S. Census Bureau (Bernard et al., 2010a and 2010b, Nunn and Trefler, 2008, Costinot et al., 2009) to test the predictions of new trade models. However, none of these papers distinguishes between intermediate inputs, capital goods and consumption

[49] Typically, in the literature forward integration is modeled as moral hazard problem and not as hold-up problem (see Lafontaine and Slade, 2007, for a review). Nevertheless, predictions are similar in the sense that a firm will choose outsourcing if the effort of the distributor is large relative to the effort of the firm.

goods in their data as is actually requested by theory.[50] One contribution of this paper is that it fills this gap between theoretical research and its empirical testing. In the following, we summarise the findings of the empirical work on intra-firm trade.

Bernard et al. (2010) assess the determinants of U.S. intra-firm imports at the HS 10-digit product level using their Linked/Longitudinal Firm Trade Transaction Database (LFTTD). They emphasise the importance of the interaction of product and country characteristics for intra-firm trade. In particular, they find that intra-firm imports are higher in capital intensive industries from capital abundant countries and lower for skill intensive products from human capital abundant countries. Bernard et al. (2010) is also the only study investigating the non-linearity in the determinants of intra-firm trade associated with the extensive and intensive margin of trade. For instance, good governance increases the likelihood that intra-firm trade takes place between two countries but reduces the share of intra-firm trade once the decision has been made to source intra-firm, i.e. to set up a foreign affiliate. Using a new index of revealed product contractibility based on the degree of a good being imported by wholesale traders, they find that the share of intra-firm imports is lower for products with a high revealed contractibility and that this effect is more pronounced for countries with weak governance. In our empirical approach, we interact a variable indicating a country's rule of law with dummies for intermediate and capital goods. Hence, their index and our dummies are related in the sense that both are measuring to what extent incomplete contracts matter for the respective good.

Nunn and Trefler (2008) use data at the HS6 level from the U.S. Census Bureau to assess the determinants of the share of intra-firm trade in total trade. Testing the theoretical predictions of Antràs (2003) and Antràs and Helpman (2004, 2008), they find that the share of intra-firm trade is increasing in the share of non-contractible inputs provided by the headquarter firm (as proxied by capital and skill intensities of industries). They also assess the role of the contracting environment on intra-firm trade. Surprisingly, they find that intra-firm imports are higher in relationship-specific industries from countries with a good rule of law.[51] According to the property rights model of Antràs and Helpman (2008), this would imply that an improvement in the contracting environment affects primarily the investment undertaken by the supplier and that therefore more incentives need to be given to the final good producer increasing integration.

Corcos et al. (2009) combine French firm level data from the EIIG (Échanges Internationaux Intra-Groupe) dataset with French customs data to estimate a logit model for the sourcing decision of French firms at the bilateral product level in 1999. Building on the Rauch (1999)

[50] Bernard et al. (2010b) refer to this shortcoming and confirm their results in a robustness check excluding final goods as identified by the HTS Imports Index of Sitchinava (2008).
[51] The variable measuring the relationship-specificity of industries is taken from Nunn (2007).

classification, they construct different measures of product complexity for imported and final products of French firms. However, they do not distinguish between intermediate inputs and consumption goods, but only between the complexity of products French firms import and sell. Similar to previous studies, they find that higher product complexity increases the likelihood of intra-firm sourcing. Furthermore, contrary to theoretical predictions and evidence in Antràs (2003) and Bernard et al. (2010a), they find that capital intensive firms tend to insource labour intensive goods from labour abundant countries.

Costinot et al. (2009) put special emphasis on adaptation as a determinant of the share of intra-firm imports. Building on the transaction cost approach, they argue that ex-post contractual frictions might require headquarters or suppliers to adapt to a problematic state, with adaptation being presumably less costly under integration. Using a new measure of sectors' routines and concentrating on sector characteristics only, they find that the share of U.S. intra-firm imports is higher in less routine sectors.

Marin (2006) uses survey data for German parent firms operating affiliates in Eastern Europe to assess the determinants of the decision to offshore or to outsource. Given data limitations, she uses an ownership threshold of 30 percent to distinguish outsourcing from offshoring investment. Using probit regressions, she finds that less capital intensive and more R&D intensive parent firms recur more to offshoring, i.e. intra-firm trade as sourcing strategy. She furthermore finds that the hold-up problem is important for the relationship between the parent and the supplier. If the supplier has no alternative purchaser for its products, then the supplier is more likely to be owned by the German parent.

Further empirical studies relying on survey data of MNEs that assess intra-firm trade on the basis of more traditional trade models include Andersson and Fredriksson (2000), Egger and Pfaffermayr (2005), Hanson et al. (2005) and Yeaple (2006). These studies typically assess intra-firm trade in relation to the activities of MNEs and not the share of intra-firm trade in total country trade. Andersson and Fredriksson (2000) analyse intra-firm trade in intermediate and finished products of Swedish MNEs applying Tobit regressions. They use parent, affiliate and host country variables to assess whether intra-firm trade in intermediates is more related to vertical integration and whether intra-firm trade in finished products is more related to horizontal integration. However, they find no support for the traditional factor proportions model since GDP per capita is positively correlated with the share of intra-firm trade in production for both intermediate and finished goods. Using intra-firm trade data of Austrian MNEs, Egger and Pfaffermayr (2005) find that markets size and unit labour costs are significant determinants of intra-firm exports as predicted by the Knowledge Capital Model (Markusen, 2002). Furthermore,

they find support for trade magnification effects, i.e. intra-firm imports and exports being complementary, as predicted by models of vertical specialisation (Yi, 2003). Yeaple (2006) investigates how the level of development of countries is related to the industry determinants of the share of intra-firm imports of U.S. parents from their affiliates in total U.S. imports. He finds that capital intensity is a significant determinant, especially for imports from developing and emerging countries. Furthermore, R&D intensity increases the share of intra-firm imports from emerging and developed countries. Also, he finds a positive impact of productivity dispersion on intra-firm trade. Hanson et al. (2005) analyse vertical production networks by assessing the determinants of intra-firm exports of intermediate inputs from U.S. parents to their foreign affiliates. They find that low trade costs, low wages for unskilled workers and a small host market increase the share of intra-firm trade in the revenues of affiliates. On the other hand, low wages for skilled workers decrease the share of intra-firm trade.

4.3 Data on Intra-Firm Trade by Type of Good

4.3.1 The Ownership Dimension

In this paper, we use data on U.S. intra-firm imports at the Harmonized System 6-digit (HS6) level for the year 2000. Data stem from the related party database of the U.S. Census Bureau in which import transactions are recorded as occurring between related parties if either of the parties owns or controls 6 percent of the outstanding voting stock or shares.[52] A drawback of the data is that no distinction is made between parent firms and affiliates, i.e. the data do not distinguish between imports where the U.S. importer is the parent firm and imports where the U.S. importer is the affiliate of a foreign parent firm. Data on intra-firm trade from the U.S. Census Bureau have also been used in the discussed papers of Nunn and Trefler (2008), Costinot et al. (2009) and Bernard et al. (2010). While Nunn and Trefler (2008) use the same level of aggregation as this paper, Costinot et al. (2009) use NAICS 4-digit level data and Bernard et al. (2010a) assess intra-firm imports at the HS10 level.

4.3.2 The Main End Use Dimension

The related party trade database of the U.S. Census Bureau distinguishes intra-firm and arm's length trade for all goods. We use the United Nation's Broad Economic Categories (BEC) classification to group imported commodities according to their main end use into intermediate

[52] I would like to thank the Census Bureau for providing me with the data.

goods, capital goods and consumption goods.[53] We use the official UN correspondence between HS 1996 and BEC to classify HS6 commodities as consumption goods, intermediate goods, capital goods and not classified goods. The correspondence is unique, i.e. each HS6 product corresponds to only one BEC category. Table 4.1 reports the 19 basic goods categories identified by the BEC classification, of which eight represent intermediate goods, six are consumption goods and two cover capital goods. The three BEC categories Motor Spirit, Passenger Motor Cars and Goods Not Elsewhere Specified are not assigned a main end use because it may differ depending on the user. For instance, passenger motor cars are consumption goods if they are used by private households and capital goods if they are used by firms.

Table 4.1: Classification by Broad Economic Categories and U.S. imports in 2000

Classification by Broad Economic Categories (BEC)	Main end use	Number of HS6 lines	Imports in Mill. USD	Total imports (%)	Intra-firm imports (%)	Arm's length imports (%)
1 Food and beverages						
11 Primary						
111 Mainly for industry	Intermediate	52	5,378.5	0.5%	7.0%	92.9%
112 Mainly for household consumption	Consumption	178	12,864.1	1.1%	18.1%	81.8%
12 Processed						
121 Mainly for industry	Intermediates	89	2,574.0	0.2%	27.1%	72.9%
122 Mainly for household consumption	Consumption	244	24,216.6	2.1%	24.6%	75.0%
2 Industrial supplies not elsewhere specified						
21 Primary	Intermediate	297	11,287.9	1.0%	26.1%	73.7%
22 Processed	Intermediate	2,313	223,895.9	19.4%	38.9%	60.9%
3 Fuels and lubricants						
31 Primary	Intermediate	9	71,021.4	6.1%	16.9%	68.1%
32 Processed						
321 Motor spirit	Not classified	1	32,646.6	2.8%	25.6%	74.4%
322 Other	Intermediate	15	9,314.2	0.8%	21.9%	49.0%
4 Capital goods (except transport equipment), and parts and accessories thereof						
41 Capital goods (except transport equipment)	Capital	627	187,081.5	16.2%	59.9%	40.1%
42 Parts and accessories	Intermediate	278	145,886.5	12.6%	62.0%	37.9%
5 Transport equipment, and parts and accessories thereof						
51 Passenger motor cars	Not classified	8	112,554.0	9.7%	95.2%	4.5%
52 Other						
521 Industrial	Capital	45	32,795.4	2.8%	56.9%	43.0%
522 Non-industrial	Consumption	19	5,144.9	0.4%	54.5%	45.2%
53 Parts and accessories	Intermediate	100	75,957.8	6.6%	54.4%	45.1%
6 Consumer goods not elsewhere specified						
61 Durable	Consumption	164	50,366.8	4.4%	43.0%	56.9%
62 Semi-durable	Consumption	411	116,845.6	10.1%	16.2%	83.8%
63 Non-durable	Consumption	219	35,460.6	3.1%	42.1%	57.8%
7 Goods not elsewhere specified	Not classified	13	1,508.0	0.1%	13.0%	81.6%

4.3.3 Intra-Firm Trade for Intermediates, Capital and Consumption Goods

Table 4.2 provides an overview of the decomposition of U.S. imports along the dimensions of ownership and end use, i.e. intermediate, consumption, capital and not classified goods. It reports

[53] The BEC classification distinguishes these three basic classes of goods in concordance with the System of National Accounts. See UN(2007) for a more detailed description. Other studies using the BEC classification to assess trade in intermediate goods are Bergstrand and Egger (2009) and Miroudot et al. (2009).

the number of traded HS commodities, imports in Millions USD, the share of the BEC category in total imports as well as the share of intra-firm and arm's lengths imports for the respective goods category.[54] Table 4.1 reports the same statistics for the full BEC classification.

Table 4.2: Decomposition of U.S. imports in 2000 by ownership and main end use

Main end use (BEC classification)	Number of HS6 lines	Imports in Mill. USD	Total imports (%)	Intra-firm imports (%)	Arm's length imports (%)
Total	5,082	1,156,801.0	100.0%	47.5%	51.2%
Intermediate	3,153	545,316.3	47.1%	43.5%	53.9%
Consumption	1,235	244,898.6	21.2%	27.2%	72.7%
Capital	672	219,876.8	19.0%	59.4%	40.5%
Not classified	22	146,708.7	12.7%	78.9%	20.9%

Table 4.2 shows that intermediates dominate trade in terms of both number of goods traded and volume. Overall, the U.S. has imported goods falling under 5,082 HS6 lines. More than 60 percent, that is 3,153 HS6 lines are classified as intermediates. There are only 1,235 and 672 types of HS6 commodities that are used as consumption and capital goods respectively. Imports of the U.S. in 2000 amounted to a value of 1,156,801 Mill. USD. Almost half of the value of imports (47.1 percent) can be attributed to intermediate goods. Consumption and capital goods are clearly less relevant accounting for only 21.2 percent and 19 percent of imports respectively. Hence, the importance of intermediate goods in world trade clearly justifies a distinct analysis of intra-firm trade by type of goods.

The share of intra-firm imports in total imports was 47.5 percent in 2000. However, the sole decomposition of goods into intra-firm and arm's length trade misses an important characteristic of intra-firm trade. That is, intra-firm trade is more prevalent in the case of intermediate and capital goods than for consumption goods. Capital goods are the category of goods which are traded most frequently between related parties with an intra-firm import share of almost 60 percent. For intermediates, more imports are at arm's length (53.9 percent) than intra-firm (43.5 percent). However, the comparison with consumption goods is still striking. Only 27.2 percent of consumption goods imports are intra-firm, while 72.7 percent of imports occur at arm's length. This discrepancy in the share of intra-firm trade between intermediates and capital goods on the one hand and consumption goods on the other hand underscores systematic differences in the characteristics of these goods. We argue in this paper that one difference is that intermediates and capital goods are more prone to the hold-up problem than consumption goods and have hence a higher share of intra-firm trade.

[54] The reported shares for intra-firm and arm's lengths imports do not sum up to 100 percent because for a small percentage of imports the ownership information is not available.

Goods which are not classified in BEC terms, had an import share of 12.7 percent, most of which can be attributed to imports of Passenger motor cars as Table 4.1 shows. Despite consisting of only 8 HS6 lines, Passenger motor cars had a share of 9.7 percent in total U.S. imports in 2000. Even more striking is that 95.2 percent of these imports were intra-firm. This high share can be explained by the fact that car producers are typically large multinational firms with subsidiaries in host markets through which they import.

4.3.4 Descriptive Statistics by Partner Country

Table 4.3 in Appendix 4.A provides country detail of trade by BEC categories and intra-firm trade. The first three columns contain the number of traded HS6 lines, total exports of the country to the U.S. in 2000 and the share of intra-firm transactions in total exports. Columns 4-8 report the shares of intermediate, capital, consumption and not classified goods in a country's exports to the U.S. as well as the shares of intra-firm trade within these BEC categories. The table is sorted in descending order of the intra-firm trade share and includes 154 countries that exported more than 10 Mill. USD to the U.S. in 2000. To ensure presentational clarity, 70 countries with an export volume below 10 Mill. USD have not been included in the table.

Across countries, the average share of intra-firm exports was 24 percent in 2000, which is clearly below the 47.5 percent overall intra-firm trade share of the U.S.. In 2000, the five largest exporters to the U.S. were Canada (214,271 Mill. USD), Japan (141,707 Mill. USD), Mexico (128,838 Mill. USD), China (98,443 Mill. USD) and Germany (55,643 Mill. USD). While the four OECD countries had all shares of intra-firm exports above the 24 percent sample average, only 18 percent of China's exports to the U.S. were between related parties. These two facts illustrate that developed countries with high trade volumes tend to engage more in intra-firm trade with the U.S. than developing countries. A natural explanation is that the data include not only intra-firm imports of U.S. parents but also intra-firm imports of U.S. affiliates from foreign parents. While many developing countries have only few multinational firms, rich industrialised countries have more multinational parents with subsidiaries in the U.S. For instance, Japan and Germany are big exporters of cars to the U.S. market, which can be seen by their export shares of 24.5 percent and 28.6 percent in the BEC category "not classified" and the respective intra-firm trade shares of 92.5 percent for Japan and 93.3 percent for Germany.

Another pattern is that less developed countries are more likely to have higher export shares in consumption goods. For instance, China's exports to the U.S. consist to a large part of consumption goods (56.7 percent) and only to a lesser extent of intermediate (22.9 percent) and capital goods (20.1 percent). Other Asian emerging economies that export relatively more consumption goods are India (47.4 percent), Vietnam (71.7 percent) and Indonesia (51.7

percent). These countries are more likely to be specialised in agriculture or textile products or in the assembly stage of the production process.

4.3.5 Descriptive Statistics for 2-digit HS (HS2) Goods Groupings

Table 4.4 provides information on U.S. imports at the HS2 level decomposed by BEC category and intra-firm trade. In addition, the third column shows the intermediation index of Bernard et al. (2010a) that captures the revealed contractibility of products. Bernard et al. (2010a) measure the contractibility of a product as the weighted average of the wholesale employment share of firms importing the product, using imports of firms as weights. Hence, product contractibility is increasing in the share of importing firms which are wholesale traders. Table 4.5 shows pairwise correlations of import shares of BEC categories at the HS2 level and the product contractibility of the respective HS2 category. While the correlation between product contractibility and the share of consumption goods in HS2 imports is significant and positive, there is a negative correlation between the index and the share of intermediates and capital goods in HS2 imports. Hence, the contractibility measure of Bernard et al. (2010a) is related to the type of good traded and lends support to our argument that intermediates and capital goods are more prone to the hold-up problem than consumption goods because they are traded in a different context.

Table 4.5: Correlation between import shares of BEC categories and product contractibility

Share in HS2 imports	Product Contractibility
Intermediate	-0.147
Consumption	0.322
Capital	-0.466

Furthermore, distinguishing between intermediate and consumption goods provides further insight into some of the puzzling components in the index. Bernard et al. point out that some HS2 product lines with a similar index value vary substantially in their intra-firm share. Table 4.4 shows that Footwear (HS 64) and Organic Chemicals (HS 29) have a comparable level of intermediation - 0.136 and 0.135 respectively - but very different levels of intra-firm import shares, i.e. 6 percent for Footwear and 62 percent for Organic Chemicals. It is important to notice that Footwear consists to 100 percent of consumption goods, while the category Organic Chemicals consists to 100 percent of intermediate goods. Hence, the breakdown into intermediates and consumption goods can provide additional explanation of the pattern of intra-firm trade.

4.4 Empirical Model

We analyse the pattern of intra-firm trade at the HS6 level relying on country variables, product (industry) variables and the interaction of product (industry) and country characteristics. Our empirical estimation strategy follows closely Bernard et al. (2010a) in terms of variables used but also in terms of functional form, especially by considering both the extensive and the intensive margin of intra-firm trade. However, we are the first to distinguish intra-firm trade in intermediates and capital goods from intra-firm trade in consumption goods. We will use two estimation strategies to assess whether the determinants of intra-firm trade differ for intermediate, consumption and capital goods. First, we estimate empirical models separately by BEC category. Second, we use dummy variables in a pooled model to assess the impact of the type of good on intra-firm trade and whether the impact of explanatory variables differs depending on the type of good.

4.4.1 Dependent Variables - Extensive and Intensive Margin

The extensive margin relates to whether intra-firm trade takes place or not and is investigated using probit models. In probit regressions the dependent variable takes the form of a dummy D_{pi} that is one if there is intra-firm trade between the U.S. and the exporting country i in HS6 product p t. If no trade is observed, the dummy is zero:

$$D_{pi}\begin{cases}=1 & if\ intra\text{-}firm\ imports_{pi}>0\\ =0 & if\ intra\text{-}firm\ imports_{pi}=0\end{cases}$$

The intensive margin of intra-firm imports relates to the volume of intra-firm trade relative to total trade and is assessed using OLS regressions. The dependent variable is the share of U.S. intra-firm imports in total U.S. imports of HS6 digit product p from country i:

$$\mathrm{S_{pi}} = \frac{\text{intra-firm imports}_{\mathrm{pi}}}{\text{total imports}_{\mathrm{pi}}} \quad if\ intra\text{-}firm\ imports_{pi}>0$$

4.4.2 Basic Estimating Equation

Since we use the same model specification for the extensive and intensive margin, we present models only once with y_{pi} indicating the dependent variable. Hence, y_{pi} denotes either D_{pi} or S_{pi} depending on whether Probit or OLS regressions are used respectively. Then, we can write our empirical model as:

$$y_{pi} = c + \alpha X_k + \beta X_i + \gamma(X_k X_i) + \varepsilon_{pi} \qquad (1)$$

where c is a constant, X_k are characteristics of NAICS6 industries k, X_i are characteristics of the exporting country i, $X_k X_i$ are interaction terms of industry and country characteristics and ε_{pi} denotes the error term. More concretely, our basic empirical model includes the following main variables:

$$y_{pi} = c + \beta_1 RuleofLaw_i + \alpha_1 capital_k + \beta_2 K/L_i + \alpha_2 skill_k + \beta_2 H/L_i + \gamma(X_k X_i) + \beta_n X_i + \varepsilon_{pi} \qquad (2)$$

Following predictions of Antràs (2003) and Antràs and Helpman (2004), we include capital intensity $capital_k$ and skilled labour intensity $skill_k$ of industry k to proxy for headquarter intensity. Using data from the NBER-CES Manufacturing Industry Database for the year 2000, $capital_k$ is the natural log of the total real capital stock per worker and $skill_k$ is the share of non-production workers in total employment.[55] While intra-firm trade shares are observed at the HS6 product level p, capital and skilled labour intensity are only available at the NAICS6 industry level k. To account for this difference in aggregation between dependent and explanatory variables, we estimate standard errors clustered at the NAICS6 level. A further drawback of industry intensities is that we cannot break down industry intensities by BEC category. Hence, we have to assume that within a NAICS industry all type of goods, i.e. intermediate, capital and consumption, have the same capital and skilled labour intensity. We address this issue in our robustness analysis, where we run regressions for homogenous industries consisting of either only consumption or intermediate goods. Following Helpman et al. (2004), we proxy for the productivity dispersion (*dispersion*) of firms in industry k using the standard deviation of the log of sales of firms in industry k. In the 1997 U.S. Census of Manufacturing, firm sales are aggregated according to 10 categories of firm sizes. Assuming that all firms within a size category have equal sales, we then calculate the size distribution of firms as the standard deviation of the log sales of the ten size categories using the number of firms in each category as weights.[56] Antràs and Helpman (2004) predict that intra-firm trade should be higher for industries which have both a high dispersion and a high headquarter intensity.

$RuleofLaw_i$ is an indicator taken from the World Bank Worldwide Governance Indicators 2009 and measures the quality of the rule of law, which comprises the quality of contract enforcement, of country i in the year 2000. Data on endowments of capital K/L_i and human capital H/L_i of

[55] Since industry intensities are available only for manufacturing industries, we do not use trade information on 63 non-manufacturing industries or 488 HS6 lines respectively.

[56] We deal with undisclosed sales data as follows. We merge two undisclosed size categories if they are neighbours in terms of size and allocate the remaining sales as inferred from the industry total to this newly merged category. We disregard undisclosed sales of an industry, if the industry has three or more undisclosed sales observations or if in the case of two undisclosed observations, the respective categories are not neighbours.

country i are taken from Hall and Jones (1999) and are measured by the natural logs of the capital stock per worker and the human capital stock per worker for the year 1988.[57] X_i denotes a set of additional country variables. These additional controls are population ($lnpop$) from the World Bank Indicators 2010 as a measure for country size and restrictiveness indices of trade (hfi_trade) and investment ($hfi\_investment$) taken from the Heritage Foundation Economic Freedom Indices. Summary statistics for explanatory variables are reported in Table 4.6. Table 4.7 in Appendix 4.A provides the respective correlation matrix.

Table 4.6: Summary statistics of explanatory variables

	Observations	Mean	Std. Dev.	Min	Max
capital	375	11.456	0.860	9.547	14.299
skilled labour	375	0.284	0.113	0.087	0.682
Dispersion	375	1.624	0.388	0.213	3.047
RuleofLaw	109	0.027	1.045	-2.267	1.925
K/L	109	9.258	1.569	5.763	11.589
H/L	109	0.587	0.292	0.072	1.215
Population	109	16.300	1.545	12.436	20.956
HFI_trade	109	0.389	0.179	0.100	0.850
HFI_investment	109	0.428	0.177	0.100	0.900
capital x K/L	20,665	0.101	1.079	-11.018	8.452
skilled labour x H/L	20,665	0.0005	0.030	-0.287	0.163

Besides investigating the separate impact of industry and country characteristics, we follow Bernard et al. (2010a) and include interactions of industry and country variables ($X_k X_i$). Concretely, we include interactions of capital intensity with capital abundance and skilled labour intensity with human capital abundance. In order to increase the interpretability of coefficients, we subtract the sample mean from industry and country variables that are used in interaction terms. For instance, the capital interaction term allows to test whether the effect of the capital intensity of industries on intra-firm trade is more or less pronounced for capital abundant exporting countries. By demeaning variables that enter interaction terms, coefficients indicate the marginal effect of capital intensity for a country with average capital abundance instead of a capital abundance of zero.

[57] Using capital stocks from Hall and Jones(1999) leads to a loss of 109 mostly small countries but including also the following economically more relevant economies: Bulgaria, Czech Republic, Kuwait, Qatar, Russia, Slovak Republic, Slovenia, Ukraine, United Arab Emirates and Vietnam.

4.4.3 Testing for Differences between Intermediates, Capital and Consumption Goods

We start our analysis by estimating equation (2) for all goods in line with Bernard et al. (2010a) and compare results to separate regressions for intermediate, consumption and capital goods. This allows us to assess whether explanatory variables, especially contract enforcement and headquarter intensities, have the same qualitative impact on intra-firm trade[58]. However, to test more thoroughly whether intermediates are more affected by the hold-up problem than consumption goods, we pool data and introduce dummies intermediate goods D_{int} and capital goods D_{cap} in regressions. First, we include only simple dummies D_{int} and D_{cap} to test whether there are significant differences in intra-firm trade between intermediate and capital goods relative to consumption goods. Second, we interact the dummies D_{int} and D_{cap} with $RuleofLaw_i$ to test our main prediction: If the hold-up problem is more severe in the case of intermediates and capital goods, then the contracting environment will be more important for these goods than for consumption goods. Third, to test for further differences in the determinants of intra-firm trade across goods types, we interact D_{int} and D_{cap} with intensities, endowments and interaction variables of capital and human capital. The general regression specification becomes then the following:

$$y_{pi} = c + D_{int} + D_{cap} + \alpha X_k + \alpha_{int}(D_{int}X_k) + \alpha_{cap}(D_{cap}X_k) + \beta X_i + \beta_{int}(D_{int}X_i) + \beta_{cap}(D_{cap}X_i) + \gamma(X_kX_i) + \gamma_{int}(D_{int}(X_kX_i)) + \gamma_{cap}\left(D_{cap}(X_kX_i)\right) + \varepsilon_{pi} \quad (3)$$

4.5 Results

4.5.1 Separate Regressions for Intermediate, Capital and Consumption Goods

Table 4.8 reports the results of regression model (2) for the share of intra-firm imports in overall imports, i.e. including all good types (columns 1-2), and separate regressions for the shares of intra-firm trade in intermediate, consumption and capital goods (columns 3-8). Results of Probit and OLS regressions show the impact of variables on the extensive and the intensive margin of intra-firm imports respectively. Since data and estimation specification follow closely Bernard et al. (2010a and 2010b), results for intra-firm trade not differentiated by goods category of columns 1 and 2 are very similar, so that we will not describe them in too much detail. While also results

[58] In a similar spirit, Bernard et al. (2010b) test the robustness of their results by estimating their model on a subset of goods, i.e. excluding finished goods, using the HTS Imports Index of Sitchinava (2008).

for intermediate goods, consumption goods and capital goods are qualitatively similar, there are some important differences we will focus on.

Table 4.8: Extensive (Probit) and intensive (OLS) margin by BEC category

	All		Intermediate		Consumption		Capital	
	Probit	OLS	Probit	OLS	Probit	OLS	Probit	OLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
RuleofLaw	0.223***	-0.024***	0.226***	-0.021**	0.170***	-0.011	0.298***	-0.064***
	(0.015)	(0.006)	(0.021)	(0.008)	(0.021)	(0.008)	(0.029)	(0.009)
capital	-0.124***	0.079***	-0.129***	0.077***	-0.208***	0.038***	-0.194***	0.062***
	(0.022)	(0.005)	(0.032)	(0.006)	(0.034)	(0.010)	(0.074)	(0.013)
K/L	0.167***	0.069***	0.275***	0.061***	0.032**	0.070***	0.175***	0.065***
	(0.016)	(0.006)	(0.025)	(0.009)	(0.015)	(0.007)	(0.029)	(0.009)
capital x K/L	0.073***	0.004	0.023	0.018***	0.040***	-0.008*	-0.048	-0.016
	(0.012)	(0.005)	(0.015)	(0.006)	(0.013)	(0.005)	(0.032)	(0.011)
skilled labour	1.286***	0.292***	1.812***	0.259***	0.597*	0.243***	0.385	0.106**
	(0.256)	(0.050)	(0.423)	(0.084)	(0.305)	(0.082)	(0.261)	(0.054)
H/L	0.035	-0.139***	0.023	-0.151***	0.066	-0.089***	0.022	-0.212***
	(0.040)	(0.015)	(0.044)	(0.023)	(0.087)	(0.022)	(0.065)	(0.032)
skilled labour x H/L	0.879***	-0.597***	0.228	-0.437***	0.355	0.011	1.088**	-0.367**
	(0.313)	(0.101)	(0.345)	(0.134)	(0.667)	(0.160)	(0.468)	(0.158)
Dispersion	0.073	0.013	0.101	0.012	0.058	0.048**	0.389***	0.003
	(0.105)	(0.022)	(0.134)	(0.029)	(0.087)	(0.024)	(0.148)	(0.021)
Population	0.242***	-0.046***	0.227***	-0.044***	0.260***	-0.058***	0.277***	-0.043***
	(0.007)	(0.002)	(0.010)	(0.004)	(0.011)	(0.003)	(0.011)	(0.004)
HFI_trade	-1.004***	0.234***	-0.578***	0.174***	-1.334***	0.304***	-1.673***	0.231***
	(0.087)	(0.026)	(0.125)	(0.039)	(0.090)	(0.034)	(0.157)	(0.054)
HFI_investment	0.248***	0.009	0.301***	-0.035	0.034	0.077***	0.622***	0.011
	(0.049)	(0.019)	(0.062)	(0.030)	(0.085)	(0.026)	(0.085)	(0.029)
Constant	-4.119***	1.136***	-4.034***	1.178***	-4.243***	1.114***	-5.088***	1.194***
	(0.217)	(0.062)	(0.262)	(0.094)	(0.232)	(0.067)	(0.342)	(0.078)
Pseudo R-squared	0.089		0.1		0.073		0.104	
R-squared		0.099		0.084		0.083		0.045
Observations	130,010	71,999	67,088	38,199	42,439	21,010	20,483	12,790
Countries	109	104	108	99	108	97	107	87
HS6 Goods	4,574	4,421	2,845	2,733	1,059	1,024	670	664
NAICS6 Industries	375	375	310	309	161	161	111	111

Notes: Regressions are run including all goods and seperately for intermediate, consumption and capital goods. The dependent variable in probit regressions is a dummy indicating whether there is intra-firm trade in a HS6 product between two countries or not, while in OLS regressions it is the share of intrafirm trade if the latter is positive. All variables entering interactions terms have been centered at the mean so that coefficients of main effects can be interpreted at sample means. Robust standard errors clustered at the 6-digit NAICS level are reported in brackets. * significant at 10%; ** at 5%; *** at 1%.

A country's rule of law is our variable of main interest, since it measures the quality of contract enforcement in the country and consequently the extent to which the hold-up problem is relevant. Column 1 shows that the higher the rule of law of the exporting country, the higher the probability that there is intra-firm trade with the U.S. for a given product. This is not surprising, as a higher rule of law can be associated with more investment security and hence U.S. multinational firms are more likely to invest. However, once a firm has invested and hence intra-firm trade is taking place, further improvements in the rule of law decrease the share of intra-firm trade (column 2). This result is in line with predictions of transaction cost theories. The better the

rule of law, the more contracts are complete and hence the less severe is the potential hold-up problem between the two parties. The costs associated with incomplete contracts decrease relatively to the costs of integration. Therefore, better contract enforcement reduces integration and intra-firm trade. Columns 4 and 8 show that the respective coefficient of rule of law is also negative and significant for intermediates and capital goods. However, in the case of consumption goods (column 6), the coefficient is very small and not significant. Hence, an improvement in the rule of law will diminish the share of intra-firm trade for intermediate and capital goods but it will not affect the share of intra-firm trade for consumption goods. This indicates that the hold-up problem is less severe in the final good producer-distributor relationship (consumption goods) than in the final good producer-supplier relationship (intermediate and capital goods).

At the intensive margin (column 2), the capital intensity of industries and capital abundance of countries significantly increase the share of intra-firm trade confirming Antràs (2003). Interestingly, the size in coefficients for capital intensity is clearly smaller for consumption goods than for intermediate and capital goods. This might indicate that headquarter intensity as proxied by the capital intensity is less important for the decision on whether to integrate or not in the case of consumption goods. Furthermore, the effect of the interaction term is different for intermediate and consumption goods. The positive impact of capital intensive industries on intra-firm trade is stronger in capital abundant countries for intermediates, while it is weaker in capital abundant countries for consumption goods.

As capital intensity, skilled labour intensity proxies headquarter intensity and is associated with significantly higher intra-firm trade at both the extensive (column 1) and intensive margin (column 2) confirming the model of Antràs and Helpman (2004) and findings of Nunn and Trefler (2008). The human capital abundance of countries has no significant impact on the probability of intra-firm trade to occur, but it decreases intra-firm imports once affiliates are established. This negative relationship between human capital abundance and the intensive margin of intra-firm trade is found for all three types of goods. The respective interaction term in column 2 between skill intensity and human capital abundance is significant and negative indicating that the positive effect of skill intensive industries on the share of intra-firm trade is even stronger for skill scarce countries. A possible explanation might be that if headquarter services can be provided at low cost across borders, firms may choose to integrate in human capital scarce countries in order to be able to provide necessary skilled labour services from the headquarters at home. Differently, in human capital abundant countries the workforce is more skilled and services can be provided locally so that no integration with the foreign final good producer is necessary. While this negative effect of the interaction term is also found in

regression using only intermediate or capital goods, the interaction term is positively signed but not significant in the case of consumption goods.

Separate regressions for intermediates, consumption and capital goods have shown some distinguishing features through differences in significance and signs of coefficients. However, in this setting, we cannot test whether coefficients of explanatory variables are significantly different for intermediate, consumption and capital goods. To do so, we proceed in the next section to estimate equation (3) using dummies for intermediates and capital goods and interactions thereof with explanatory variables.

4.5.2 Pooled Regressions including Intermediate and Capital Goods Dummies

Table 4.9 reports regression results for pooled data including dummies for intermediates and capital goods and interactions thereof with explanatory variables. Columns 1 and 2 correspond to equation (1) but include additionally an intermediate dummy and a capital good dummy. In columns 3 and 4 the interaction of these dummies with the rule of law variable are added and columns 5 and 6 correspond to estimating equation (3) with dummies being interacted furthermore with capital and human capital variables.

Results in columns 1 and 2 show that the pattern of intra-firm trade is significantly different for consumption, intermediate and capital goods. The coefficient of the intermediate dummy is significant and positive for both the extensive (column 1) and the intensive margin (column 2). Hence, the probability of intra-firm taking place between the exporting country and the U.S. is significantly higher for an intermediate good as compared to consumption goods. Furthermore, if there is intra-firm trade for a good, the share of intra-firm trade tends to be significantly higher for both intermediate and capital goods as compared to consumption goods.

To test whether contract enforcement is more important for intermediates and capital goods, we interact the rule of law variable with the respective dummies. Improvements in the contracting environment increase the extensive margin of intra-firm trade, i.e. the probability of intra-firm trade to occur (column 3). This effect is stronger for both intermediate and capital goods as compared to consumption goods. Hence, a sound contracting environment is more important for intermediate and capital goods than for consumption goods in the decision to set up a foreign affiliate.

Table 4.9: Extensive (Probit) and intensive (OLS) margin using BEC dummies

	Probit	OLS	Probit	OLS	Probit	OLS
	(1)	(2)	(3)	(4)	(5)	(6)
Dint	0.111*	0.066***	0.122**	0.062***	0.175***	0.076***
	(0.061)	(0.013)	(0.062)	(0.013)	(0.049)	(0.013)
Dcap	0.065	0.084***	0.063	0.087***	0.192***	0.109***
	(0.057)	(0.012)	(0.058)	(0.011)	(0.051)	(0.012)
RuleofLaw	0.221***	-0.026***	0.101***	0.001	0.169***	-0.007
	(0.015)	(0.006)	(0.019)	(0.007)	(0.020)	(0.008)
Dint x RuleofLaw			0.176***	-0.028***	0.059**	-0.017
			(0.017)	(0.007)	(0.029)	(0.011)
Dcap x RuleofLaw			0.221***	-0.076***	0.126***	-0.061***
			(0.022)	(0.009)	(0.033)	(0.012)
capital	-0.150***	0.068***	-0.150***	0.067***	-0.208***	0.040***
	(0.024)	(0.006)	(0.024)	(0.006)	(0.035)	(0.009)
Dint x capital					0.075	0.035***
					(0.048)	(0.012)
Dcap x capital					0.068	0.023
					(0.078)	(0.015)
K/L	0.165***	0.066***	0.167***	0.065***	0.077***	0.059***
	(0.017)	(0.006)	(0.018)	(0.006)	(0.016)	(0.007)
Dint x K/L					0.161***	-0.002
					(0.025)	(0.010)
Dcap x K/L					0.108***	0.001
					(0.029)	(0.010)
capital x K/L	0.075***	0.006	0.049***	0.010**	0.040***	-0.007
	(0.011)	(0.005)	(0.010)	(0.004)	(0.013)	(0.004)
Dint x (capitalx K/L)					-0.019	0.025***
					(0.019)	(0.007)
Dcap x (capital x K/L)					-0.092**	-0.009
					(0.036)	(0.012)
skilled labour	1.270***	0.219***	1.287***	0.215***	0.659**	0.219***
	(0.288)	(0.058)	(0.289)	(0.058)	(0.311)	(0.081)
Dint x skilled labour					1.185**	0.049
					(0.568)	(0.129)
Dcap x skilled labour					-0.189	-0.112
					(0.411)	(0.099)
H/L	0.034	-0.142***	0.032	-0.143***	0.137	-0.100***
	(0.040)	(0.015)	(0.039)	(0.016)	(0.096)	(0.022)
Dint x H/L					-0.16	-0.043
					(0.101)	(0.031)
Dcap x H/L					-0.208*	-0.079**
					(0.117)	(0.039)
skilled labour x H/L	0.892***	-0.589***	0.337	-0.352***	0.345	0.02
	(0.323)	(0.098)	(0.267)	(0.097)	(0.673)	(0.161)
Dint x (skilled labour x H/L)					-0.169	-0.442**
					(0.761)	(0.209)
Dcap x (skilled labour x H/L)					0.703	-0.385*
					(0.803)	(0.224)
Dispersion	0.078	0.013	0.082	0.011	0.116	0.018
	(0.113)	(0.023)	(0.114)	(0.023)	(0.100)	(0.022)
Population	0.240***	-0.046***	0.246***	-0.048***	0.247***	-0.048***
	(0.007)	(0.002)	(0.007)	(0.002)	(0.007)	(0.002)
HFI_trade	-1.005***	0.223***	-1.013***	0.223***	-1.029***	0.227***
	(0.088)	(0.025)	(0.088)	(0.025)	(0.086)	(0.025)
HFI_investment	0.252***	0.011	0.238***	0.012	0.248***	0.011
	(0.049)	(0.019)	(0.050)	(0.019)	(0.050)	(0.019)
Constant	-3.976***	1.078***	-4.080***	1.110***	-4.227***	1.087***
	(0.239)	(0.067)	(0.242)	(0.067)	(0.208)	(0.062)
Pseudo R-squared	0.09		0.093		0.096	
R-squared		0.105		0.108		0.11
Observations	130,010	71,999	130,010	71,999	130,010	71,999

Notes: The dependent variable in probit regressions is a dummy indicating whether there is intra-firm trade in a HS6 product between two countries or not, while in OLS regressions it is the share of intrafirm trade if the latter is positive. All variables entering interactions terms have been centered at the mean so that coefficients of main effects can be interpreted at sample means. Robust standard errors clustered at the 6-digit NAICS level are reported in brackets. * significant at 10%; ** at 5%; *** at 1%.

Column 4 shows that an improvement in a country's rule of law has no significant impact on the share of intra-firm trade for consumption goods, but it decreases significantly the share of intra-firm trade for intermediates and capital goods. Hence, intermediates and capital goods differ significantly from consumption goods in their reaction to improvements in contract enforcement, which indicates that these goods are more prone to the hold-up problem than consumption goods. This result is closely related to the findings of Bernard et al. (2010a) and Nunn and Trefler (2008). Bernard et al. (2010a) interact an index of revealed product contractibility with a measure of a country's governance quality and find that intra-firm trade is higher for products with limited contractibility. We have shown in the descriptive section that their contractibility index is closely related to a good being an intermediate or a consumption goods. Hence, an alternative interpretation could be that intermediate goods have a lower revealed contractibility than consumption goods. Nunn and Trefler (2008) interact a measure of the relationship-specificity of industries from Nunn (2007) with a country's rule of law. Their opposite finding of a slightly positive relationship of relationship-specificity of industries in countries with good rule of law on the share of intra-firm trade can be explained by property rights models (see Antràs and Helpman, 2008) but might be also a result from the fact that they did not deal separately with the extensive and intensive margin of intra-firm trade.

In column 5 and 6, we test whether industry and country characteristics have a different impact on intra-firm trade depending on the type of good. Two results are worth highlighting. First, in column 6 intuitive findings from separate regressions can be confirmed. While intra-firm trade shares are higher in capital intensive industries, this effect is significantly stronger for intermediate goods. Furthermore, intermediate goods also differ significantly from consumption goods regarding the interaction of industry and country characteristics. The capital intensity of industries increases intra-firm trade. In the case of consumption goods, the effects tends to be stronger if the country is capital scarce, while for intermediates the relationship is stronger if the country is capital abundant. Similarly, regarding the interaction between skill intensity and human capital abundance, intermediates and capital goods differ significantly from consumption goods.

4.5.3 Robustness Analysis

Next, we assess the robustness of results using three different sets of regressions. Table 4.10 reports results for these robustness regressions using the most extensive specification of equation 3. In columns 1 and 2 regressions include a joint intermediate and capital goods dummy, i.e. the dummy is one if the HS6 good is either an intermediate or a capital good and 0 in the case of a consumption good. Intermediate and capital goods are both used in the production process by a

firm and capital goods might also be tailored to the needs of the acquiring final goods firms. Hence, the hold-up problem arises in the same context for intermediates and capital goods and might be evaluated jointly against the pattern of consumption goods. Columns 3 and 4 present results for homogeneous industries only. With homogeneous industries we mean industries that produce either only intermediates or only consumption goods. Since capital and skilled labour intensities cannot be distinguished according to goods type, in other regressions we have to assume that within a NAICS industry intermediate goods, capital goods and consumption goods are all produced with the same capital and skilled labour intensity. By looking only at the subset of homogenous industries, we assess whether this assumption matters for results. Finally, we also run regressions for a subsample of intermediates and consumption goods (columns 5 and 6). For intermediates, we include only parts and accessories of capital goods and transport equipment as they better represent inputs frequently utilised in international production networks, and exclude thereby intermediates derived from oil for instance. Furthermore, we restrict consumption goods to the BEC category consumption goods not elsewhere specified (durables, semi-durables and non-durables) and do not consider food and beverages as well as consumption goods related to transport equipment.

Main results are robust across all three models. First, the share of intra-firm trade is significantly higher for intermediates than for consumption goods. The joint intermediate-capital dummy in columns 1 and 2 as well as the intermediate dummy in the regression for parts and accessories columns and consumption goods n.e.s. (columns 5 and 6) are positive and significant for both the extensive and intensive margin of intra-firm trade. Furthermore, in the case of homogeneous industries, intermediate goods are traded significantly more intra-firm as compared to consumption goods (column 4).

Also the second main finding regarding the importance of the contracting environment is supported. The impact of the rule of law variable on the share of intra-firm trade is not significant (column 2 and 6) or even positive for consumption goods (4). The interaction term between rule of law and the intermediate dummy is significant and negative in all three regressions for the intensive margin. Hence, better contract enforcement increases outsourcing as measured by arm's length trade as compared to intra-firm trade for intermediates but not or not to a similar extent for consumption goods. This indicates that the hold-up problem is indeed more a problem in the context of intermediates than of consumption goods.

Table 4.10: Using a joint intermediate-capital dummy and different industry subsamples

	Joint intermediate-capital dummy		Homogeneous industries only		Parts and accessories vs. consumption goods n.e.s.	
	Probit	OLS	Probit	OLS	Probit	OLS
	(1)	(2)	(3)	(4)	(5)	(6)
Dint	0.154***	0.083***	0.002	0.075***	0.380***	0.111***
	(0.049)	(0.012)	(0.094)	(0.024)	(0.054)	(0.013)
RuleofLaw	0.169***	-0.007	0.212***	0.027***	0.191***	-0.011
	(0.020)	(0.008)	(0.025)	(0.006)	(0.022)	(0.009)
Dint x RuleofLaw	0.073***	-0.027***	-0.013	-0.029**	0.204***	-0.065***
	(0.027)	(0.010)	(0.038)	(0.012)	(0.030)	(0.012)
capital	-0.202***	0.040***	-0.163***	0.052***	-0.113***	0.051***
	(0.036)	(0.010)	(0.052)	(0.015)	(0.035)	(0.013)
Dintx capital	0.092**	0.030***	0.085	0.015	0.06	-0.023
	(0.045)	(0.011)	(0.075)	(0.020)	(0.077)	(0.019)
K/L	0.078***	0.059***	0.115***	0.031**	0.049***	0.066***
	(0.016)	(0.007)	(0.029)	(0.015)	(0.017)	(0.008)
Dint x K/L	0.152***	0	0.138***	0.004	0.173***	0.01
	(0.022)	(0.009)	(0.040)	(0.019)	(0.032)	(0.010)
capital x K/L	0.040***	-0.007	0.060***	-0.007	0.060***	-0.010*
	(0.013)	(0.004)	(0.019)	(0.009)	(0.019)	(0.006)
Dint x (capitalx K/L)	-0.024	0.027***	-0.027	0.029***	-0.166***	-0.006
	(0.019)	(0.007)	(0.026)	(0.011)	(0.037)	(0.016)
skilled labour	0.628**	0.218***	0.763*	0.138	0.560*	0.264***
	(0.309)	(0.081)	(0.427)	(0.103)	(0.332)	(0.095)
Dint x skilled labour	0.754	0.036	0.864	0.267	-0.182	-0.378***
	(0.502)	(0.116)	(0.877)	(0.201)	(0.402)	(0.111)
H/L	0.138	-0.100***	-0.149	-0.106***	0.073	-0.097***
	(0.096)	(0.022)	(0.107)	(0.030)	(0.104)	(0.022)
Dint x H/L	-0.155	-0.044	0.109	-0.041	-0.359***	0.003
	(0.099)	(0.028)	(0.118)	(0.049)	(0.124)	(0.032)
skilled labour x H/L	0.366	0.021	-0.824	0.042	-0.07	-0.293
	(0.674)	(0.161)	(0.806)	(0.153)	(0.803)	(0.187)
Dint x (skilled labour x H/L)	0.102	-0.594***	0.24	-0.468*	1.195	-0.212
	(0.730)	(0.189)	(0.959)	(0.275)	(0.962)	(0.237)
Dispersion	0.08	0.016	0.045	0.018	0.118*	0.054***
	(0.111)	(0.023)	(0.119)	(0.027)	(0.067)	(0.016)
Population	0.246***	-0.048***	0.235***	-0.050***	0.275***	-0.056***
	(0.007)	(0.002)	(0.011)	(0.004)	(0.010)	(0.002)
HFI_trade	-1.018***	0.224***	-0.806***	0.170***	-1.243***	0.288***
	(0.087)	(0.025)	(0.137)	(0.037)	(0.078)	(0.031)
HFI_investment	0.244***	0.011	-0.01	-0.027	0.155*	0.068***
	(0.049)	(0.019)	(0.068)	(0.033)	(0.081)	(0.020)
Constant	-4.152***	1.084***	-3.832***	1.162***	-4.490***	1.107***
	(0.225)	(0.066)	(0.262)	(0.097)	(0.207)	(0.048)
Pseudo R-squared	0.095		0.083		0.111	
R-squared		0.108		0.151		0.122
Observations	130,010	71,999	60,209	32,544	54,383	31,578
Countries	109	104	109	101	108	98
HS6 Goods	4,574	4,421	2,324	2,242	1,149	1,136
NAICS6 Industries	375	375	194	194	217	217

Notes: In columns 1-2, the dummy Dint is one if the HS6 good is either an intermediate or a capital good. In columns 3-6 only intermediate and consumption goods enter the regressions and therefore Dint is a simple intermediate good dummy. Homogeneous industries are industries that import either only intermediates or only consumption goods. Parts and accessories include BEC categories 42 (for capital goods) and 53 (for transport equipment), while the selected consumption categories are 61 (durable), 62 (semi-durable) and 63 (non-durable). All variables entering interactions terms have been centered at the mean so that coefficients of main effects can be interpreted at sample means. Robust standard errors clustered at the 6-digit NAICS level are reported in brackets. * significant at 10%; ** at 5%; *** at 1%.

Also other results are similar to findings presented in column 6 of Table 4.9. High capital and human capital stocks are associated with high and low shares of intra-firm trade in all three models (columns 2, 4 and 6). Furthermore, both measures of headquarter intensity of industries, capital and skilled labour, have a positive impact on the intensive margin of intra-firm trade in all regressions. A noteworthy difference is that while the positive effect of capital intensity on intra-firm trade is found to be stronger for intermediates also in the case of a joint intermediate-capital dummy (column 2), the effect is not significant anymore in the industry subsamples of columns 4 and 6.

As a further robustness test we address the issue of the inclusion of both U.S. parents and of U.S. affiliates of foreign parents in trade data. Table 4.11 presents results for equation (3) for two country subsamples[59]. In column 1 and 2, we follow Nunn and Trefler (2008) and include only countries for which at least two-thirds of intra-firm U.S. imports are imported from U.S. parents as indicated by MNE data for 1997 from the Bureau of Economic Analysis. In columns 3 and 4, we use the World Bank country classification and exclude high-income countries of the year 2000. Main results are confirmed also for these two subsamples of countries. Intra-firm trade is significantly higher for intermediate and capital goods relative to consumption goods. Furthermore, the impact of a country's rule of law on intra-firm trade is significantly different at both the extensive and intensive margin for intermediate and capital goods as compared to consumption goods.

Finally, Table 4.11 also reports results for OLS regressions including HS6 product and country fixed effects. In all three specifications (columns 5-7), the intermediate goods dummy is now negatively signed but also not significant. Hence, much of the explanatory power of the simple dummies is now captured by product fixed effects. However, the main result is still confirmed, namely that improvements in a country's rule of law lead to stronger reductions in the share of intra-firm imports for intermediate and capital goods as compared to consumption goods. Furthermore, column 7 confirms findings of Table 4.9 that intermediate goods differ significantly from consumption goods regarding the interaction of capital intensity and capital abundance.

[59] Some control variables are omitted in the table due to space constraints.

Table 4.11: Using different country samples and product and country fixed effects

	Excluding countries with many parent firms		Excluding high-income countries		Full sample using product and country fixed effects		
	Probit	OLS	Probit	OLS	OLS	OLS	OLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dint	0.073	0.097***	0.003	0.120***	-0.044	-0.151	-0.045
	(0.046)	(0.012)	(0.047)	(0.015)	(0.430)	(0.429)	(0.429)
Dcap	0.096*	0.170***	0.045	0.222***	-0.773*	-0.168	-0.523
	(0.051)	(0.016)	(0.049)	(0.019)	(0.429)	(0.427)	(0.427)
RuleofLaw	0.073***	-0.043***	0.027	-0.030***			
	(0.021)	(0.009)	(0.021)	(0.009)			
Dint x RuleofLaw	0.144***	-0.049***	0.128***	-0.030**		-0.037***	-0.028***
	(0.030)	(0.013)	(0.031)	(0.015)		(0.004)	(0.004)
Dcap x RuleofLaw	0.195***	-0.130***	0.065*	-0.080***		-0.091***	-0.080***
	(0.035)	(0.016)	(0.039)	(0.016)		(0.005)	(0.005)
capital	-0.186***	0.059***	-0.203***	0.055***			
	(0.032)	(0.011)	(0.036)	(0.014)			
Dint x capital	0.073	-0.012	0.088*	-0.018			
	(0.048)	(0.014)	(0.050)	(0.016)			
Dcap x capital	0.065	0.019	0.141*	0.029			
	(0.083)	(0.026)	(0.084)	(0.030)			
K/L	0.108***	0.040***	0.024	0.038***			
	(0.022)	(0.011)	(0.017)	(0.008)			
Dint x K/L	0.212***	0.007	0.166***	0.012			
	(0.030)	(0.012)	(0.023)	(0.010)			
Dcap x K/L	0.204***	0.028**	0.084***	0.023**			
	(0.038)	(0.014)	(0.029)	(0.011)			
capital x K/L	0.098***	-0.001	0.061***	-0.003	-0.003*	0.001	-0.021***
	(0.019)	(0.005)	(0.014)	(0.006)	(0.001)	(0.002)	(0.003)
Dint x (capitalx K/L)	-0.089***	0.019*	-0.015	0.001			0.036***
	(0.027)	(0.010)	(0.022)	(0.011)			(0.003)
Dcap x (capital x K/L)	-0.146***	-0.003	-0.041	0.002			0.015*
	(0.054)	(0.017)	(0.047)	(0.015)			(0.008)
skilled labour	0.642**	0.190**	0.524	0.235**			
	(0.270)	(0.093)	(0.319)	(0.104)			
Dint x skilled labour	0.773	0.157	0.991	0.102			
	(0.588)	(0.112)	(0.616)	(0.132)			
Dcap x skilled labour	-0.532	-0.089	-0.389	-0.115			
	(0.394)	(0.118)	(0.416)	(0.135)			
H/L	0.459***	0.048*	0.334***	-0.015			
	(0.088)	(0.028)	(0.086)	(0.029)			
Dint x H/L	-0.770***	-0.140***	-0.489***	-0.171***			
	(0.114)	(0.044)	(0.103)	(0.039)			
Dcap x H/L	-0.429**	-0.210***	-0.071	-0.277***			
	(0.170)	(0.063)	(0.129)	(0.056)			
skilled labour x H/L	0.17	0.052	-0.315	0.045	-0.671***	-0.410***	-0.301***
	(0.745)	(0.221)	(0.731)	(0.324)	(0.050)	(0.052)	(0.113)
Dint x (skilled labour x H/L)	-0.954	-0.226	-0.901	-0.934**			-0.172
	(0.930)	(0.348)	(0.871)	(0.382)			(0.134)
Dcap x (skilled labour x H/L)	-0.816	-0.314	0.515	0.029			-0.086
	(1.100)	(0.310)	(0.965)	(0.389)			(0.153)
Pseudo R-squared	0.084		0.05				
R-squared		0.17		0.186	0.322	0.325	0.327
Observations	50,472	23,185	56,417	24,063	130,346	72,144	72,144
Countries	75	70	81	76			

Notes: The dependent variable in probit regressions is a dummy indicating whether there is intra-firm trade in a HS6 product between two countries or not, while in OLS regressions it is the share of intra-firm trade if the latter is positive. Columns 1 and 2 include countries for which the share of U.S. parents in intra-firm imports is 2/3. In columns 3 and 4, high-income countries are excluded. All variables entering interactions terms have been centered at the mean so that coefficients of main effects can be interpreted at sample means. Robust standard errors clustered at the 6-digit NAICS level are reported in brackets. * significant at 10%; ** at 5%; *** at 1%.

4.6 Conclusions

In this paper, we distinguish intra-firm trade in intermediates, intra-firm trade in capital goods and intra-firm trade in consumption goods. By making this distinction between intermediates and other good types, we are able to test more accurately theoretical models focusing on incomplete contracts and intra-firm trade. We show that the pattern of intra-firm trade differs significantly between intermediates and capital goods on the one hand, and final consumption goods on the other hand. The share of intra-firm trade in total trade is significantly higher for intermediate and capital goods as compared to consumption goods. We furthermore find that a main factor driving these differences is that intermediates and capital goods are more sensitive to the hold-up problem as compared to consumption goods. In particular, we find that improvements in the contracting environment of a country cause larger reductions in the shares of intra-firm trade of intermediates and capital goods compared to consumption goods. This result suggests that intermediates and capital goods require more relationship-specific investments of contracting parties as compared to consumption goods. A related explanation is that intermediate, capital and consumption goods are traded in a different context. While intermediates and capital goods are mainly traded between a final good producer and a supplier, much of trade in final goods is taking place between the final good producer and a distributor, i.e. a retailer or a wholesale trader. We further support our arguments by providing correlations between the three good types and the index of product contractibility of Bernard et al. (2010a), which they measure as the average wholesale employment share of firms importing the product.

Appendix 4.A: Tables

Table 4.7: Correlation matrix of explanatory variables

	RuleofLaw	capital	K/L	capital x K/L	skilled labour	H/L	skill. lab. x H/L	Dispersion	Population	HFI_trade	HFI_invest.
RuleofLaw	1										
capital	0.118	1									
K/L	0.815	0.134	1								
capital x K/L	-0.084	-0.011	-0.131	1							
skilled labour	0.083	0.231	0.081	-0.017	1						
H/L	0.787	0.113	0.740	-0.102	0.083	1					
skilled labour x H/L	-0.045	-0.013	-0.058	0.192	0.034	-0.052	1				
Dispersion	0.019	0.259	0.021	-0.029	-0.090	0.011	-0.002	1			
Population	-0.351	0.091	-0.372	-0.042	-0.019	-0.311	-0.015	0.026	1		
HFI_trade	-0.660	-0.055	-0.738	0.042	-0.045	-0.638	0.025	-0.011	0.536	1	
HFI_investment	-0.291	0.005	-0.363	0.045	-0.021	-0.322	-0.002	0.001	0.455	0.549	1

Table 4.3: Countries (part 1/4)

Country	Number of HS6 lines	Imports in Mill.s	Intra-firm (%)	Inter-mediate (%)	Intra-firm in Intermediates (%)	Consumption (%)	Intra-firm in Consumption(%)	Capital (%)	Intra-firm in Capital (%)	Not class.	Intra-firm in Not class. (%)
Lesotho	26	140.1	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0
Palau	13	13.5	0.0	0.5	0.0	99.5	0.0	0.0	0.0	0.0	0.0
F. States of Micronesia	36	13.7	0.0	1.2	0.0	98.8	0.0	0.0	0.0	0.0	0.0
Brunei	71	383.6	0.0	48.7	0.0	46.9	0.0	0.1	1.0	4.2	0.0
Equatorial Guinea	14	153.3	0.0	76.1	0.0	0.0	0.0	0.0	0.0	23.9	0.0
Republic of Yemen	28	144.2	0.1	79.4	0.1	0.9	0.7	0.0	0.0	19.6	0.0
Turkmenistan	35	28.0	0.1	18.3	0.0	81.7	0.1	0.0	0.0	0.0	0.0
Mozambique	25	24.2	0.3	45.1	0.4	54.9	0.1	0.0	100.0	0.1	0.0
Oman	126	253.0	0.3	16.9	0.7	83.1	0.3	0.0	0.0	0.0	0.0
Swaziland	75	52.2	0.5	30.1	0.7	69.6	0.2	0.2	72.8	0.0	0.0
Mauritius	163	285.1	0.7	6.2	0.8	93.5	0.5	0.2	75.9	0.0	0.0
Uzbekistan	87	34.4	0.7	82.7	0.7	16.6	0.6	0.7	2.6	0.0	0.0
Algeria	40	2,688.1	0.8	39.1	1.3	0.0	3.7	0.0	0.0	60.9	0.5
Botswana	45	12.4	0.9	9.8	0.0	87.4	1.0	2.2	0.0	0.6	0.0
Cambodia	212	821.7	0.9	0.4	14.8	99.6	0.8	0.0	0.0	0.0	0.0
Faroe Islands	29	31.3	1.1	3.1	0.2	96.6	0.9	0.2	100.0	0.0	0.0
Madagascar	181	156.6	1.1	8.1	5.6	91.8	0.7	0.0	0.8	0.0	0.0
Namibia	60	40.4	1.2	18.4	3.8	47.8	0.0	0.5	100.0	33.3	0.0
Bangladesh	350	2,413.4	1.9	1.5	2.0	98.5	1.9	0.0	0.0	0.0	0.0
Ethiopia	55	28.5	2.2	97.4	2.3	2.4	0.3	0.3	0.0	0.0	0.0
Macedonia	160	137.5	2.4	32.9	4.5	65.8	1.3	0.3	10.2	0.9	0.0
Myanmar (Burma)	213	467.2	2.4	4.8	13.6	95.1	1.9	0.1	1.7	0.0	0.0
Cameroon	116	145.0	2.6	61.9	3.9	1.0	7.8	0.4	37.3	36.6	0.0
British Virgin Islands	78	22.4	2.7	66.3	4.1	32.3	0.1	1.4	0.0	0.0	0.0
Uruguay	290	280.4	2.9	58.3	3.5	41.5	2.0	0.2	3.6	0.0	0.0
Peru	874	1,955.8	2.9	62.2	4.1	32.0	1.1	0.1	12.9	5.7	0.0
Netherlands Antilles	179	606.2	3.0	26.4	5.0	3.2	1.3	0.4	49.2	70.0	2.1
Nepal	285	226.8	3.2	0.7	0.5	99.3	3.3	0.0	0.0	0.0	0.0
Pakistan	835	2,157.1	3.5	17.4	1.5	80.5	3.9	1.5	5.7	0.6	7.4
Haiti	256	293.7	3.5	4.5	26.3	95.2	2.4	0.3	6.0	0.0	0.0
Macao	372	1,262.4	3.6	5.7	21.2	92.5	1.4	1.8	59.2	0.0	0.0
Fiji	171	139.2	3.6	12.1	0.0	87.7	4.1	0.2	0.0	0.0	0.0
Angola	29	3,338.9	3.6	95.5	3.6	0.0	0.0	0.0	27.0	4.5	3.4
Estonia	265	539.4	3.8	9.3	18.1	4.2	14.6	0.6	14.2	85.9	1.7
Uganda	31	23.0	3.8	67.4	3.1	32.5	5.3	0.1	0.0	0.0	0.0
Mongolia	120	116.1	3.9	1.7	21.0	98.2	3.6	0.1	13.9	0.1	0.0
Iran	72	168.3	4.2	17.5	0.2	82.5	5.1	0.0	0.0	0.0	0.0
Jordan	253	68.5	4.5	4.1	32.5	94.9	2.8	0.7	36.7	0.3	95.3

Table 4.3: Countries (part 2/4)

Country	Number of HS6 lines	Imports in Mill.s	Intra-firm (%)	Inter-mediate (%)	Intra-firm in Intermediates (%)	Consumption (%)	Intra-firm in Consumption(%)	Capital (%)	Intra-firm in Capital (%)	Not class.	Intra-firm in Not class. (%)
Papua New Guinea	32	36.0	4.7	63.9	6.5	35.8	0.5	0.3	97.4	0.0	100.0
Lebanon	272	68.3	4.7	37.3	4.7	61.4	4.6	1.2	6.0	0.0	0.0
Paraguay	99	39.1	4.7	81.1	4.2	18.4	6.0	0.5	38.9	0.0	0.0
Azerbaijan	41	19.9	4.7	12.3	0.0	66.1	7.2	0.0	0.0	21.6	0.0
Vietnam	566	816.6	5.4	24.0	12.4	71.7	3.2	0.3	54.1	4.0	0.0
Moldova	98	105.1	6.0	72.1	8.1	27.9	0.6	0.1	0.0	0.0	0.0
Zimbabwe	196	112.0	6.5	67.8	9.2	32.1	0.8	0.0	0.0	0.0	0.0
Grenada	35	21.8	6.5	77.0	7.9	22.0	0.2	0.9	39.6	0.1	0.0
Armenia	105	22.1	6.5	13.9	37.0	81.6	1.3	4.5	6.6	0.0	0.0
Syria	292	144.9	6.7	3.9	20.9	62.3	4.4	0.2	47.2	33.7	9.1
Greenland	11	15.5	6.7	0.1	79.2	99.8	6.5	0.1	100.0	0.0	0.0
Latvia	262	288.6	7.0	34.9	17.5	5.5	15.7	1.0	0.8	58.7	0.0
India	2710	10,486.1	7.4	49.9	7.8	47.4	5.2	2.3	41.3	0.4	13.0
Belize	100	86.8	7.4	7.7	0.0	91.2	8.1	1.1	0.0	0.0	0.0
United Arab Emirates	574	808.1	7.4	48.9	14.0	50.6	0.8	0.3	18.3	0.2	75.6
Egypt	626	822.9	7.7	22.8	10.4	64.9	7.8	0.2	21.4	12.1	1.2
Nicaragua	225	590.3	7.9	17.5	11.7	82.5	7.1	0.0	0.0	0.0	0.0
Bulgaria	561	225.3	8.2	38.1	11.1	58.1	6.0	3.2	16.0	0.6	0.0
Guyana	149	120.3	8.6	51.1	3.7	48.6	13.7	0.3	3.8	0.0	0.0
Belarus	221	103.7	8.6	59.6	13.7	34.8	0.9	1.2	7.8	4.5	0.0
Qatar	78	424.4	9.0	66.8	12.9	32.0	1.0	0.0	35.2	1.1	5.6
Ecuador	677	2,204.0	9.1	56.3	3.1	36.2	20.2	0.1	12.3	7.4	0.0
Panama	451	240.6	9.2	29.0	5.6	54.4	13.9	1.2	2.6	15.5	0.0
Turkey	1441	2,970.8	9.6	37.8	13.7	58.8	7.0	2.4	12.9	1.0	0.0
Kenya	303	99.8	9.8	33.7	6.9	62.4	10.7	3.9	19.9	0.0	0.0
Cyprus	152	18.5	10.0	20.2	17.8	60.0	10.4	19.7	0.7	0.0	0.0
Greece	824	541.5	10.4	48.6	10.1	39.5	12.9	2.2	15.2	9.7	0.0
Ghana	213	202.2	10.9	75.5	8.7	3.9	2.5	0.0	0.0	20.6	20.4
Guatemala	694	2,562.4	12.2	23.9	2.6	76.0	15.3	0.2	5.8	0.0	0.0
Lithuania	341	129.9	12.4	45.1	20.3	47.1	6.9	1.1	0.1	6.6	0.0
Hong Kong	2250	10,593.0	13.6	27.5	32.1	65.0	4.7	7.5	23.3	0.0	0.0
Ivory Coast	176	366.3	13.6	76.8	17.4	1.8	3.0	0.4	50.7	21.0	0.0
Sri Lanka	567	1,989.8	13.8	9.6	30.5	89.6	11.5	0.7	68.9	0.0	0.0
Congo, Dem. Rep.	67	211.9	14.5	99.2	14.6	0.4	0.2	0.0	4.2	0.4	0.0
Venezuela	915	17,266.8	14.8	72.1	17.7	1.5	5.6	0.2	19.9	26.3	7.2
Georgia	117	22.9	14.9	29.2	29.4	21.1	19.2	3.1	73.2	46.7	0.0
South Africa	1604	4,062.5	15.2	85.9	13.3	8.5	4.5	4.2	66.9	1.5	39.5
Tanzania	69	32.7	15.4	79.5	7.6	20.3	46.1	0.2	1.2	0.0	0.0

Table 4.3: Countries (part 3/4)

Country	Number of HS6 lines	Imports in Mill.s	Intra-firm (%)	Inter-mediate (%)	Intra-firm in Intermediates (%)	Consumption (%)	Intra-firm in Consumption(%)	Capital (%)	Intra-firm in Capital (%)	Not class.	Intra-firm in Not class. (%)
Bahrain	73	318.0	15.4	47.4	32.3	49.0	0.3	0.1	0.0	3.5	0.0
Barbados	176	34.3	15.5	41.1	11.7	32.2	9.4	26.7	28.5	0.0	0.0
Argentina	1276	2,956.5	15.7	62.0	16.9	21.7	18.9	0.7	20.9	15.6	6.5
Ukraine	543	864.4	16.7	79.3	8.2	10.1	18.1	8.9	94.0	1.8	0.0
Zambia	37	16.6	17.6	91.8	19.2	8.1	0.0	0.0	0.0	0.0	0.0
Chile	820	3,164.4	18.2	51.4	21.9	46.0	14.8	0.2	4.4	2.4	5.4
China	3810	98,443.0	18.3	22.9	20.3	56.7	10.7	20.1	37.6	0.3	0.7
Malawi	33	68.1	19.0	72.8	21.8	27.0	11.5	0.2	0.0	0.0	0.0
Tunisia	304	88.6	20.3	11.3	49.0	56.7	21.1	3.1	3.4	28.8	9.3
Monaco	127	20.0	20.5	32.9	5.4	38.3	47.4	1.3	38.6	27.5	0.0
Taiwan	3143	39,293.8	21.9	47.1	23.3	19.9	10.3	32.8	27.1	0.2	3.8
Romania	600	458.4	22.0	49.4	23.7	45.6	21.8	3.7	10.9	1.2	0.0
Croatia	334	138.2	22.2	70.8	15.6	18.8	29.8	9.5	58.0	0.9	0.0
Indonesia	1652	10,243.7	22.9	34.0	30.2	51.7	11.7	12.6	50.5	1.7	14.1
French Polynesia	49	42.7	23.7	83.6	21.8	16.4	33.1	0.0	0.0	0.0	0.0
Colombia	1192	6,271.4	23.7	65.6	23.8	19.7	18.6	0.2	49.1	14.6	30.3
Aruba	56	1,155.0	24.0	12.9	52.2	0.1	82.4	0.0	0.0	86.9	19.7
Slovenia	663	306.6	24.7	41.0	26.4	48.0	26.1	10.7	12.1	0.2	1.7
Israel	2091	12,358.0	25.0	69.3	22.8	10.9	13.8	19.0	40.5	0.8	0.7
Spain	2941	5,229.1	25.1	50.6	33.2	32.7	13.7	10.3	35.2	6.4	3.7
Trinidad and Tobago	335	2,149.1	25.4	72.0	30.7	2.7	13.8	0.1	4.4	25.2	11.5
Kazakhstan	75	429.7	25.4	97.0	26.0	2.5	8.7	0.0	0.0	0.5	0.0
Russia	1326	7,718.6	26.7	80.6	31.0	9.8	9.0	0.8	65.7	8.9	3.5
Congo, Rep.	80	507.2	27.2	61.7	24.2	0.5	17.1	0.0	85.5	37.8	32.2
Bosnia-Hercegovina	98	15.7	28.1	54.2	1.8	44.0	60.7	0.6	69.5	1.2	0.0
Australia	2403	5,721.9	28.3	55.7	24.9	30.4	21.3	8.6	49.8	5.4	69.2
Poland	1288	983.2	28.5	53.2	33.4	38.5	15.5	8.3	57.5	0.0	0.0
Brazil	2348	12,995.6	29.5	56.2	34.0	17.8	5.9	19.1	32.9	6.9	44.8
Kuwait	114	2,452.7	31.1	81.6	25.1	0.7	1.0	0.0	3.5	17.7	59.9
Italy	3738	24,049.3	31.6	38.8	34.0	44.2	29.0	14.0	36.0	3.0	19.8
Portugal	1272	1,501.0	31.8	41.3	50.0	39.7	13.4	10.2	50.2	8.8	8.0
Bolivia	239	179.7	32.5	47.8	38.3	46.4	18.3	0.1	11.1	5.7	100.0
Thailand	2084	16,085.6	34.4	28.3	51.9	48.6	10.6	22.9	63.5	0.2	0.7
Czech Republic	1387	1,035.0	34.4	45.1	31.1	19.8	19.0	34.2	47.5	0.9	43.3
Norway	1297	5,451.7	35.5	66.8	29.3	5.5	23.6	4.8	53.6	22.9	52.7
Nigeria	204	9,676.2	36.4	69.3	25.8	0.0	24.3	0.0	31.3	30.6	60.2
St Lucia	108	20.1	36.4	63.7	37.1	30.2	41.5	6.1	3.9	0.0	0.0
Maldives	56	93.1	37.2	0.3	0.0	99.7	37.3	0.0	0.0	0.0	0.0
Iraq	33	4,392.9	37.2	81.6	34.9	0.0	0.0	0.0	0.0	18.4	47.5

Table 4.3: Countries (part 4/4)

Country	Number of HS6 lines	Imports in Mill.s	Intra-firm (%)	Inter-mediate (%)	Intra-firm in Intermediates (%)	Consumption (%)	Intra-firm in Consumption(%)	Capital (%)	Intra-firm in Capital (%)	Not class.	Intra-firm in Not class. (%)
Morocco	482	448.8	38.6	57.8	62.2	35.2	3.8	0.4	67.0	6.6	15.7
New Zealand	1342	1,951.2	39.5	44.1	60.9	49.9	20.4	6.0	40.0	0.0	0.0
Gabon	45	2,036.1	40.3	71.3	26.9	0.0	1.9	0.0	0.0	28.6	74.0
Belgium	2918	9,388.2	41.2	65.7	33.8	8.2	45.2	10.0	60.5	16.1	57.9
France	3858	27,750.3	41.4	45.3	53.8	25.4	28.6	27.4	35.3	1.8	5.9
Slovakia	454	239.0	42.5	55.2	40.6	24.5	43.8	20.4	46.0	0.0	100.0
Iceland	284	239.0	44.0	9.0	38.1	84.5	45.0	6.5	39.7	0.0	0.0
Canada	4459	214,271.4	45.6	57.3	31.8	8.7	31.0	16.0	55.6	18.0	87.8
El Salvador	540	1,905.6	45.8	10.0	4.4	88.3	49.7	1.7	85.4	0.0	0.0
Dominican Republic	942	4,263.8	46.0	15.1	59.2	74.2	36.3	10.8	94.3	0.0	0.0
Bahamas	170	247.0	46.5	47.7	70.8	28.4	44.6	0.7	6.5	23.2	0.0
Denmark	2007	2,801.7	47.2	44.5	56.3	31.2	33.2	21.2	51.8	3.0	23.3
Jamaica	276	607.2	48.8	43.5	58.0	56.3	41.9	0.2	12.5	0.0	0.0
Philippines	1456	13,706.0	50.1	55.4	57.7	24.7	15.5	19.9	72.3	0.0	15.7
United Kingdom	4088	39,310.4	50.4	53.3	46.3	16.7	45.5	18.8	53.0	11.2	72.6
St Kitts and Nevis	113	34.6	51.1	88.9	54.3	6.1	0.0	4.9	56.8	0.0	0.0
Suriname	82	128.5	51.7	84.8	60.9	14.9	0.0	0.3	32.4	0.0	0.0
Honduras	459	3,048.7	51.9	8.8	26.4	91.0	54.5	0.2	3.9	0.0	100.0
Austria	2196	2,987.4	52.6	55.8	53.0	17.1	56.6	23.3	41.6	3.7	95.8
Saudi Arabia	415	14,236.0	55.2	81.3	55.3	0.5	2.8	0.0	36.1	18.1	56.1
Netherlands	3144	8,672.7	55.4	45.1	53.9	21.8	46.9	20.8	63.5	12.3	62.5
Korea, South	3044	39,158.8	55.9	44.0	54.8	15.2	15.1	27.7	63.5	13.1	91.4
Switzerland	2966	9,267.3	57.0	46.4	52.4	30.7	62.9	22.9	58.4	0.1	22.6
Luxembourg	344	309.9	59.0	92.6	58.3	5.1	78.2	2.3	40.6	0.0	100.0
Finland	1455	3,163.7	62.8	51.1	68.6	5.0	23.7	20.2	58.8	23.7	61.9
Malaysia	1651	25,056.6	65.2	50.8	64.8	14.8	39.1	33.4	79.3	1.0	0.9
Germany	4147	55,642.6	66.8	38.9	58.4	8.3	57.4	24.2	52.3	28.6	93.3
Mexico	3632	128,838.0	67.0	43.9	57.1	20.0	54.1	23.3	81.4	12.8	94.8
Malta	150	455.9	68.3	84.5	79.5	6.7	1.6	3.6	27.9	5.2	0.0
Costa Rica	798	3,441.4	69.9	43.8	67.2	50.2	70.5	6.0	86.0	0.0	0.0
Hungary	1082	2,678.8	70.1	32.8	54.0	7.4	35.1	52.2	81.3	7.6	96.8
Sweden	2378	9,108.6	72.6	38.5	68.1	15.0	62.8	18.9	72.5	27.6	84.2
Singapore	1604	17,830.2	73.9	45.8	71.3	5.4	24.8	47.1	84.6	1.7	3.1
Japan	3877	141,707.0	75.5	40.4	68.8	10.2	74.2	24.9	70.0	24.5	92.5
Ireland	1741	15,764.3	77.8	84.0	82.6	8.7	43.9	6.9	66.5	0.4	6.0
Guinea	57	86.7	88.4	98.6	89.5	0.9	19.8	0.6	0.0	0.0	0.0
Liberia	31	45.1	89.2	99.3	89.6	0.1	0.0	0.6	34.8	0.0	0.0
Liechtenstein	188	287.4	90.3	78.2	90.8	1.1	0.9	20.7	93.3	0.0	0.0
New Caledonia	32	31.4	97.3	97.6	99.6	2.3	0.0	0.0	0.0	0.0	0.0

Table 4.4: HS2 industries (part 1/2)

HS2	Chapter	Interme diation	Number HS2	Total imports	of wich intra-firm (%)	Interm. (%)	of wich intra-firm (%)	Cons. (%)	of wich intra-firm (%)	Capital (%)	of wich intra-firm (%)	Not class. (%)	of wich intra-firm (%)
1	Live animals	0.023	16	1,928.9	1.7	99.6	1.7			0.4	0.5		
66	Umbrella, walkingsticks	0.334	7	283.6	2.5	11.4	3.1	88.6	2.4				
46	Straw; basketware	0.379	6	300.4	3.6			100.0	3.6				
67	Feathers and down articles	0.44	8	1,090.8	3.9	65.9	5.4	34.1	1.0				
50	Silk	0.327	10	293.7	5.6	99.8	5.6	0.2	16.2				
14	Vegetable products	0.414	10	53.1	5.8	100.0	5.8						
64	Footwear, gaiters	0.136	29	14,855.6	6.2			100.0	6.2				
6	Trees and plants	0.516	12	1,159.8	6.9	47.3	8.8	52.7	5.2				
41	Raw hides, skins, leather	0.345	34	1,166.7	7.3	100.0	7.3						
9	Coffee, tea, spices	0.474	32	3,199.4	7.9	73.4	7.1	26.6	10.1				
65	Headgear and parts thereof	0.415	11	1,244.9	8.3	2.8	2.7	97.2	8.5				
51	Wool, woven fabric	0.223	36	414.5	9.1	98.3	9.2	1.7	4.8				
52	Cotton	0.529	131	2,104.2	9.6	99.0	9.0	1.0	70.6				
16	Preparations of meat, fish	0.339	26	2,219.5	10.5	0.2	16.4	99.8	10.5				
3	Fish, crustaceans	0.469	86	8,152.5	10.9	0.0	0.3	100.0	10.9				
42	Leather; saddlery and harness	0.314	22	7,131.1	10.9	0.5	59.9	99.5	10.7				
44	Wood articles; wood charcoal	0.213	68	15,448.5	11.2	94.0	11.3	6.0	9.5				
71	Pearls, precious metals, coin	0.135	50	29,797.0	11.4	76.3	11.5	21.4	12.0	0.1	29.3	2.2	1.0
53	Vegetable textile fibres	0.5	30	185.1	11.6	100.0	11.6						
12	Oil seeds, grains, plants	0.181	42	822.9	11.9	100.0	11.9						
97	Works of art, antiques	0.068	7	5,860.9	12.1			100.0	12.1				
78	Lead and articles thereof	0.631	10	214.7	12.1	100.0	12.1						
5	Animal products	0.433	17	539.7	12.3	100.0	12.3						
43	Furskins and artificial fur	0.454	17	330.4	12.8	26.5	22.4	73.5	9.4				
63	Other made up textile articles	0.291	59	4,572.7	13.6	5.1	21.6	94.9	13.1				
36	Explosives	0.247	8	267.0	13.6	96.2	14.0	3.8	2.1				
58	Woven fabrics; tapestries	0.369	41	591.4	13.6	99.2	13.7	0.8	3.2				
26	Ores, slag and ash	0.03	32	1,568.4	13.9	100.0	13.9						
57	Carpets, floor coverings	0.384	23	1,464.4	14.1			100.0	14.1				
74	Copper and articles thereof	0.186	59	5,125.5	14.6	98.3	14.8	1.7	5.0				
62	Apparel, not knitted or crocheted	0.232	119	32,735.1	15.0			100.0	15.0				
55	Manmade staple fibres	0.373	115	1,165.7	16.1	98.4	16.4	1.6	0.4				
88	Aircraft, spacecraft	0.024	15	18,167.6	17.0	29.0	19.1	0.2	30.4	69.2	16.2	1.5	7.4
4	Dairy produce; honey	0.433	27	1,037.1	17.0	17.1	52.2	82.9	9.8				
61	Knitted or crocheted apparel	0.207	113	26,356.9	17.3			100.0	17.3				
49	Printed books, newspapers	0.122	19	3,489.1	18.7	20.7	22.5	79.3	17.7				
10	Cereals	0.172	15	805.8	20.8	80.6	22.9	19.4	12.0				
7	Vegetables	0.46	56	2,647.3	20.9	1.1	0.4	98.9	21.1				
2	Meat	0.341	53	3,371.7	21.7	1.1	14.6	98.9	21.8				
27	Mineral fuels, oils, waxes	0.019	40	121,566.1	22.0	73.1	20.7					26.9	25.6
68	Stone, plaster, cement	0.295	52	3,431.6	22.4	99.9	22.4	0.1	23.6				
69	Ceramic products	0.247	29	4,067.6	22.7	55.8	31.9	44.2	11.0				
13	Gums, resins	0.374	12	493.5	23.1	100.0	23.1						
47	Pulp of wood	0.088	20	3,380.9	23.2	100.0	23.2						
15	Animal, vegetable fats and oils	0.297	46	1,383.6	23.3	67.5	12.4	32.5	46.0				
60	Knitted or crocheted fabrics	0.465	18	1,004.0	24.4	100.0	24.4						
94	Furniture; prefab buildings	0.179	37	23,826.2	25.0	32.7	38.7	51.6	16.6	15.7	23.8		
22	Beverages, spirits	0.241	21	8,040.6	25.2	2.0	20.7	98.0	25.3				

Table 4.4: HS2 industries (part 2/2)

HS2	Chapter	Interme diation	Number HS2	Total imports	of wich intra-firm (%)	Interm. (%)	of wich intra-firm (%)	Cons. (%)	of wich intra-firm (%)	Capital (%)	of wich intra-firm (%)	Not class. (%)	of wich intra-firm (%)
80	Tin and articles thereof	0.274	8	340.6	25.3	100.0	25.3						
20	Vegetables, fruit, nuts	0.447	44	2,605.0	25.6			100.0	25.6				
24	Tobacco	0.108	9	1,130.2	26.2	56.1	23.5	43.9	29.6				
95	Toys, games	0.199	43	19,244.7	26.5	0.7	15.9	89.9	25.1	9.4	41.3		
11	Milling industry products	0.301	34	310.3	29.4	88.6	30.8	11.4	18.3				
23	Residues from food industries	0.13	23	615.5	29.7	79.6	21.4	20.4	62.0				
81	Other base metals	0.173	36	1,106.7	30.4	100.0	30.4						
83	Misc. articles of base metal	0.196	36	4,612.8	30.6	88.6	33.8	9.7	5.6	1.7	8.5		
79	Zinc and articles thereof	0.242	10	1,343.6	30.9	100.0	30.9						
56	Wadding, yarns, ropes, cables	0.293	34	849.1	31.2	94.2	28.4	5.8	75.6				
96	Misc. manufactured articles	0.259	50	2,852.4	31.3	27.6	36.6	71.5	29.5	1.0	9.3		
8	Fruit and nuts	0.345	53	3,917.7	31.5	1.4	8.7	98.6	31.8				
89	Ships, boats, etc.	0.034	14	1,193.0	31.7			92.4	33.1	6.4	13.8	1.2	19.6
45	Cork articles	0.409	7	175.1	31.7	100.0	31.7						
33	Oils; perfumery	0.234	35	2,635.9	32.6	16.8	35.5	83.2	32.0				
19	Cereals, flour, milk	0.482	17	1,775.6	32.9	5.8	36.8	94.2	32.7				
73	Articles of iron or steel	0.214	122	14,082.8	33.6	82.0	34.8	13.8	26.7	4.1	33.0		
17	Sugars	0.123	16	1,489.4	33.8	42.9	13.1	57.1	49.3				
82	Tools, implements, cutlery	0.212	66	4,522.6	34.9	46.9	52.7	28.5	19.8	24.5	18.4		
28	Inorganic chemicals+Z77	0.094	186	7,019.3	35.3	100.0	35.3						
21	Misc. edible preparations	0.262	16	1,240.1	36.6	7.1	57.6	92.9	35.0				
54	Manmade filaments	0.282	66	2,089.4	37.7	99.8	37.7	0.2	39.1				
34	Soap, waxes, candles	0.195	23	1,491.6	37.9	36.3	54.0	63.7	28.8				
86	Railway locomotives	0.025	24	1,827.8	38.1	43.4	51.9			56.6	27.5		
25	Salt; earths and stone	0.106	72	2,731.2	39.1	100.0	39.1						
59	Textile fabrics	0.211	25	791.3	39.2	98.0	38.3	2.0	81.3				
39	Plastics and articles thereof	0.192	126	18,977.1	39.5	73.4	46.4	26.6	20.4				
93	Arms and ammunition	0.373	17	836.4	39.8	12.6	62.3	30.3	45.1	0.2	22.7	57.0	32.1
48	Paper; articles of paper pulp	0.101	109	15,385.2	40.5	94.0	39.2	6.0	59.6				
70	Glass and glassware	0.141	66	4,373.4	41.9	78.7	48.9	21.3	16.1				
72	Iron and steel	0.193	171	14,597.2	42.0	100.0	42.0						
18	Cocoa	0.175	11	1,404.3	43.8	69.2	40.1	30.8	52.0				
91	Clocks and watches	0.322	55	3,354.0	46.4	3.5	37.8	92.0	46.1	4.5	60.1		
76	Aluminum and articles thereof	0.1	36	9,193.8	46.9	93.6	47.7	5.2	35.4	1.2	29.5		
92	Musical instruments	0.327	23	1,412.8	49.2	14.7	44.2	85.3	50.1				
75	Nickel and articles thereof	0.05	17	1,542.6	49.3	100.0	49.3						
31	Fertilisers	0.056	26	1,713.5	50.0	100.0	50.0						
38	Misc. chemical products	0.09	62	4,388.6	56.6	88.6	53.6	11.4	79.9				
32	Tanning or dyeing extracts	0.162	46	2,707.3	57.6	98.1	58.2	1.9	26.4				
84	Nuclear reactors, machinery	0.102	511	179,439.2	58.1	45.0	56.6	2.1	38.0	52.9	60.2		
90	Instruments	0.095	160	36,098.9	59.2	25.0	52.8	11.2	56.7	63.9	62.1		
35	Starches, glues, enzymes	0.168	15	1,245.0	60.0	94.9	60.3	5.1	53.3				
29	Organic chemicals	0.135	310	34,049.8	61.7	100.0	61.7						
40	Rubber and articles thereof	0.118	72	10,093.3	62.8	96.3	64.0	3.7	30.9				
85	Electrical machinery	0.084	293	184,992.2	64.6	53.9	65.5	14.0	64.2	32.1	63.1		
30	Pharmaceutical products	0.027	29	12,170.2	72.0	24.5	53.7	75.5	77.9				
37	Photographic goods	0.043	36	2,707.0	77.1	91.4	77.7	8.6	70.6				
87	NonRailway vehicles	0.012	76	164,767.5	85.3	16.5	50.9	2.3	61.6	12.8	81.6	68.4	95.1

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