Essays on International Trade
Theory and Evidence on the Determinants and Implications of Firms' Import Behaviour

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Abstract
This thesis aspires to further contribute to our understanding of both the determinants as well as the implications of intermediate goods trade. Faced with intensifying global competition, firms are increasingly developing their production process and their sourcing strategies beyond national borders in order to take advantage of lower costs, superior quality and technological advances.

In the first two chapters, I analyse firm-level import decisions in an environment allowing for unintentional exchanges of import-relevant information between firms. I build on the idea that any import-specific knowledge acquired by established importers, in a given region/industry, spills over to prospective importers lowering the costs associated with entry in international markets for intermediates. Chapter 1, using firm-level import data on the universe of Swedish firms, at the product level and by source market for the period 1998-2011, provides evidence for the existence of import spillovers and offers insights into the mechanisms through which they operate. Chapter 2, sets out a theoretical framework formalising import spillovers and their implications for the firm’s import behaviour and for consumer welfare.

In the third and last chapter of this thesis, I turn to intermediate import dependence with an aim to explain the lack of sensitivity of trade flows to exchange rate movements. I propose a tractable framework and study how real devaluations affect firm-level export decisions and export performance, as well as aggregate exports and welfare in an environment where final good production uses both domestic and imported intermediates.

Keywords: international trade, extensive margins of trade, international sourcing, hierarchical sorting, information spillovers, devaluations, intermediate import dependence.

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ESSAYS ON INTERNATIONAL TRADE

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Evangelia Pateli
Στην οικογένειά μου
Acknowledgements

'Better late than never' some say and here I am, almost eight years after I first set out for my 'Ithaka'. Indeed, the voyage has been a long one, 'full of adventure, full of discovery'. Long and exciting but also difficult and as much as I tried to 'keep Ithaka always in my mind', just like the Poet advises, there have been several moments I lost sight of it, fearing I was never destined to reach it. And as the journey (finally) comes to an end, there are a few people I wish to thank for their help, their kindness, their support, their patience and their love.

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The 16 months I spent as a Visiting Researcher with the Globalisation Team, at the Centre for Economic Performance (CEP) in the London School of Economics have been exceptionally productive and inspiring. I am deeply

*Ithaka, is an island in the Ionian Sea. Homer's Odyssey, focuses on the return journey of Odysseus (Ulysses), the king of Ithaka, to his home island after the fall of Troy. Burdened with nostalgia, Odysseus is determined to make it home after the ten-year Trojan war but alas, he has to confront the wrath of Poseidon, fight the Cyclops, the Laestrygonians, resist the Sirens, escape the spells of Circe and the possessiveness of Calypso. Another ten years pass by before Odysseus arrives to Ithaka, where he has to fight once again to win back his palace, infested in his absence by the suitors who hope to usurp his kingdom and his queen. In 1911, the Greek poet, Constantine Peter Cavafy wrote 'Ithaka', inspired by Odysseus' return journey, as recited by Homer. The return to 'Ithaka' represents the Journey of Life. The experience, the knowledge, the wisdom acquired on the way, the journey itself is all the traveller should ask for.
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me over the hectic last months and for kindly allowing me to perform my experiments in our fridge, where I secretly grow new forms of life that will one day overturn the despicable patriarchal society we live in.

This thesis was finalised in London, where for the past two years I have been working at the Competition and Markets Authority.† I heartily thank my line manager James Rutt, for exploring every option available in trying to help me graduate while having a full time job and for supporting my professional development and wellbeing.

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‘Wise as you will have become, so full of experience, you will have understood by then what these Ithakas mean.’‡

Indeed. And so I sail for other islands. Thank you all.

Stockholm, Sweden
Spring 2018

† Any views presented in this thesis are entirely my own and not linked to my employer.
‡ From the poem Ithaka of C.P. Cavafy.
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Uppsatser om utrikeshandels

Denna avhandling syftar till att bidra till vår förståelse av såväl bestämningsfaktorerna för, som effekterna av, handel med mellanprodukter.

De två inledande kapitlen undersöker huruvida oavsiktliga utbyten av importrelevant information mellan företag (ett fenomen som kallas spridningseffekter i litteraturen) påverkar beslut om internationella inköp på företagsnivå. Min utgångspunkt är att klustrifiering av importörer kan generera viktig information som andra företag kan få tillgång till, vilket sänker de fasta kostnaderna som rör insatsvaror från utlandet och därmed underlättar företagens beslut om att följa efter.

Kapitel 1
Kluster av importörer och svenska företags inköpsbeteende

I det första kapitlet genomför jag en empirisk undersökning av importspridningseffekternas natur och relevans vid beslut om internationella inköp på företagsnivå. Jag undersöker särskilt huruvida kombinationen av det enskilda beslutet att börja importera en viss produkt och ursprungsmarknaden (dvs. typ av mellanprodukt) påverkas av närvaron av näraliggande importörer, utan påverkan av vare sig observerad eller icke-observerad het-

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erogenitet.

Den empiriska analysen baseras på en ovanligt detaljerad uppsättning data om svenska företag sammantagna, vilken innehåller uppgifter om importer under åren 1998-2011, på produkt-, företags- och landnivå. Flera definitioner av spridningseffekter har beaktats, i syfte att utforska olika dimensioner av de artspecifika importbesluten och olika kanaler för informationsspridning. Min undersökning utvisar att antalet importörer av samma slag som ligger i samma område som företaget, och som är verksamma inom samma bransch, kan förknippas med en procents högre sannolikhet att börja importera samma produkt från samma land.

Ett antal viktiga resultat framträdde:

a. Spridningsmekanismen visar sig vara som störst inom den specifika typen av mellanprodukt som köps in, vilket antyder att informationskomponenten i de fasta inköpskostnaderna primärt består av information som rör kombinationen av den specifika produktens och ur sprungsmarknadens egenskaper.

b. Branschövergripande band uppstår som en viktig kanal för överföring av relevant importinformation, vilket pekar mot att spridningen inte är begränsad till den region eller bransch inom vilken företaget är verksamt. Resultatet visar särskilt att information som är relevant för import som kanaliseras via branschövergripande band sprids främst via band bakåt, dvs. band mellan ett företag och dess kunder.

c. Branschgemensamma spridningseffekter förstärks av den fysiska närheten, vilket antyder att det har blivit lättare att lära sig av konkurrenternas
internationella aktiviteter (i synnerhet import) då dessa geografiskt sett befinner sig i närheten och därför går att observera direkt.

d. Etablerade importörers utmärkande särdrag påverkar spridningseffekternas styrka. Beslut om import underlättas intressant nog huvudsakligen av närvaron av importörer som, i fråga om organisationsstruktur samt ägarstruktur, är jämförbara med det företag som står inför inköpsbeslutet.

Mina resultat är stabila även med hänsyn till företags- och regionegenskaper som antas kunna påverka importbeslutet.

Kapitel 2
Spridningseffekter och marginaler för globala inköp

Här introduceras en spridningsmekanism i en modell för internationella inköp med heterogena företag, monopolistisk konkurrens och fri tillgång. Spridningseffekter uppfattas som en informationsexternalitet mellan befintliga och presumtiva importörer av en mängd mellanprodukter. De förutsätts verka genom att sänka de fasta kostnaderna i samband med internationella inköp. Såvitt jag vet är detta det första försök som görs att formalisera importspridningsmekanismen, liksom att utforska dess konsekvenser. Detta är även en av ett fåtal avhandlingar som undersöker inköpsbeslut på företagsnivå inom ett ramverk som bekräftar att inköpsbeslut påverkar företagets marginalkostnader och därför inte kan beaktas som ett isolerat fenomen. Mina resultat utvisar att spridningseffekter har potential att främja tillgången till ett bredare utbud av mellanprodukter, vilket utökar det utrymme för kostnadsbesparinger som uppstår genom handeln med insatsvaror och
sänker priserna för konsumenterna. I vissa fall visas dock spridningseffekterna snedvrida företagens inköpsbeslut till förmån för mellanprodukter av sämre kvalitet och/eller kompatibilitetsegenskaper. Dessutom utvisar resultaten att om man utökar en modell för internationella inköp så att den inkluderar spridningseffekter, bryter den ned den strikt hierarkiska ordning för den omfattande inköpsmarginen som andra modeller i litteraturen påvisar, och förbättrar därmed dessas matchning med data.

Även om nominella och reala växelkurser fluktuerar mycket, kan vi konstatera en relativt liten effekt på handelsflödena som en effekt av valutakursförändringar. I avhandlingens tredje och sista kapitel använder jag mig av mellanprodukternas importberoende, i syfte att förklara bristen på handelsflödenas känslighet för valutakursfluktuationer och för att utmana den utbredda uppfattningen att devalveringar i reala termer alltid stärker exporten.
This thesis aspires to contribute to our understanding of the determinants and the implications of intermediates trade. Faced with intensifying competition, firms are increasingly developing their production process and sourcing strategies\textsuperscript{i} beyond national borders, in order to take advantage of lower costs, superior quality and technological advances. Trade in intermediates has therefore grown to be a salient part of international trade, currently accounting for around 2/3 of the total volume of global trade flows.\textsuperscript{ii} In parallel, the import content of exports for OECD countries, has increased by circa 10 percentage points since 1995 to reach 24%, reflecting the rapidly progressing verticalisation of the production process at the global scale.\textsuperscript{iii} In addition, there is growing evidence that trade in intermediates is a vehicle for knowledge transfers between countries leading to productivity gains and bolstering innovation, suggesting that its relevance extends beyond its material share in global trade flows.\textsuperscript{iv}

\textsuperscript{i} The management literature distinguishes the concept of strategic sourcing from the international purchasing process. Here, I use the term global/international sourcing to refer to the process of importing intermediate inputs from abroad.

\textsuperscript{ii} IMF estimates.

\textsuperscript{iii} OECD, latest available data 2011. The import content of exports (or intermediate input dependence) is defined as the share of imported inputs in the overall exports of a country. It is often referred to as the ‘foreign value-added share of gross exports’ and is considered a measure of international ‘backward linkages’ in analyses of global value chains.

\textsuperscript{iv} See Böler et al. [2015], Goldberg-Koujianou et al. [2010], Halpern et al. [2015], Kasahara and Rodrigue [2008], Kasahara et al. [2016] and others.
In the first two chapters, I investigate whether unintentional exchanges of import-relevant information between firms (a phenomenon that the literature has come to name spillovers) affect firm-level international sourcing decisions. I build on the idea that the presence of established importers in a region/industry, may generate important information that can be accessed by non-importing firms, lowering the fixed costs related to international sourcing and hence, facilitating entry into international markets for intermediates. The effect of such information externalities on firms’ trade participation decisions, has mainly been studied in an empirical context and from the exporter’s perspective. The respective literature on import spillovers, is rather limited. I contribute to this literature, by providing empirical evidence for the existence of import spillovers and proposing a theoretical framework to study the mechanisms through which they operate.

Chapter 1- Importers’ clusters and the sourcing behaviour of Swedish firms

In Chapter 1, I investigate the existence of import spillovers and explore their nature, using a rich data set, monitoring the universe of Swedish firms between 1998 and 2011 and containing firm-level import data by product code and by source market. In particular, I study whether a firm’s decision to start importing a given product-country pair (i.e. intermediate product variety) is influenced by the import behaviour of nearby firms, controlling for observed and unobserved heterogeneity.

Employing several definitions of spillovers and alternative specifications, I investigate how the spillover mechanism affects the different dimensions of
firm-level import decisions and explore the channels of information diffusion. I find that the number of same-variety importers in the firm's neighbourhood and industry, is associated with a 1% higher probability of starting to import that same product-country pair. This is a substantial impact considering that there are approximately 400,000 active firm-product-country import links per year in the data.

A number of key findings arise:

a. The spillover mechanism is shown to be the strongest when specific to the intermediate product variety being sourced, suggesting that import-relevant information is attached to the characteristics of a particular product and source-market combination and not transferrable across products and/or countries.

b. Inter-industry linkages emerge as an important channel for the transmission of import relevant information, suggesting that spillovers are not confined within the boundaries of the region-industry cluster where the firm operates. In particular, I find that import relevant information channelled via inter-industry linkages is primarily diffused through backward linkages i.e. ties between a firm and its buyers.

c. Intra-industry spillovers are reinforced by physical proximity, suggesting that learning from competitors' international activities (importing in particular) is facilitated when they are geographically close and hence directly observable.

d. The characteristics of established importers affect the strength of the spillover mechanism. Interestingly, import decisions are mainly faci-
itiated by the presence of importers that are comparable in terms of organisation and ownership structure, to the firm facing the sourcing decision.

Results survive a set of rigorous robustness checks.

Chapter 2 - Spillover effects and the margins of global sourcing

In the second chapter, I introduce a spillover mechanism in a model of international sourcing with heterogeneous firms, monopolistic competition and free entry. Spillovers are perceived as an information externality between existing and prospective importers of an intermediate product variety and are assumed to operate via lowering the fixed costs associated with international sourcing. To the best of my knowledge this is the first attempt to formalise the import spillover mechanism and to explore its implications. It is also one of a few papers to study firm-level import behaviour within a framework accommodating interdependencies between sourcing decisions. I find that spillovers promote access to a wider range of intermediates, expanding the scope for cost savings arising from inputs trade and lowering consumer prices. However, in some cases spillovers are shown to bias firms’ sourcing decision towards intermediate product varieties of inferior quality attributes. In addition, I find that extending a model of international sourcing to include spillovers, breaks down the strict hierarchical order of the extensive margin of sourcing other models in the literature deliver, thus improving their match with the data.
Although movements of nominal and real exchange rates are large, we observe relatively little response of trade flows to exchange rate fluctuations. In the third and last chapter of this thesis, I turn to intermediate import dependence with an aim to explain the lack of sensitivity of trade flows to exchange rate movements and challenge the widely held view that devaluations always bolster export performance.

Chapter 3 - When do devaluations pay?

I propose a tractable framework to study how real devaluations affect firm-level export decisions and export performance, as well as aggregate exports and welfare in an environment where final goods production uses both domestic and imported intermediates. The model accommodates some well documented facts on the characteristics of exporters, while taking into account trade in intermediate inputs and in particular, forward linkages (i.e. domestic value added exported in intermediates re-exported to third countries). In this context, devaluations have a weaker effect in terms of accruing cost-competitiveness gains and adjustments along both the extensive and intensive margins of trade, compared to the benchmark setting where we don’t account for trade in intermediates. The model also provides conditions for which devaluations lead to a negative adjustment along the extensive margin of trade and loss of export revenue both at the firm and at the aggregate level.
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importers’ clusters & the sourcing
decisions of swedish firms
1.1 Introduction

The present paper investigates whether firm-level international sourcing decisions are influenced by the import behaviour of neighbouring firms. I build on the idea that the presence of established importers (in a region and/or industry) may generate important information that spills over to prospective importers, lowering the fixed costs associated with entry into international markets for intermediates. The empirical analysis is based on an exceptionally detailed dataset of the universe of Swedish firms containing information on imports at the product level and by source market, for the period 1998-2011.

The import side of trade has received relatively less attention in the literature and this tendency carries over to the study of spillovers. Therefore, the main contribution of this paper is that it bridges the gap in the literature, not only providing evidence for the existence of import spillovers but also detailing their nature and offering insights into the mechanisms through which they operate.

The effect of peers on firms’ international decisions has mainly been studied from the exporter’s perspective. The literature on export spillovers has been developed among others by Aitken et al. [1997], Greenaway and Kneller...
The early literature on export spillovers provides mixed evidence for the mechanism. More recently, Koenig [2009] and Koenig et al. [2010], using a detailed dataset on French individual export flows, at the product-level and by destination country find that export spillovers are sector- and destination-specific. Koenig et al. [2010] argue that in light of increasing support for the destination-specific nature of export spillovers it is unsurprising that previous studies using aggregated data (across destinations), have failed to provide strong unanimous support for this effect. Choquette and Meinen [2014], provide further insights by investigating the different channels through which the export spillover effects come to play (labour mobility, intra-industry linkages and inter-industry linkages).

Regarding import spillovers, the respective literature is rather limited. Previously, López and Yadav [2011], using Chilean plant-level data have found a positive correlation between the number of importers in the same region, regardless of their industry affiliation, and the probability of importing intermediate inputs. Having access to a more comprehensive data set, I am able to look at a broader set of questions and further unpack the nature of import spillovers. Recently, Bisztray et al. [2017], use firm-level data from Hungary and estimate knowledge spillovers between importers through spatial and managerial networks.¹

Policy makers have long prioritised export promotion. Thereby, as opposed to gathering information related to exporting activities, public interventions

¹ Unpublished manuscript.
are rare in the case of importing. As a result, informal informational transfers across firms may be an important channel for lowering the cost of entry into international markets for intermediates. Fully understanding the determinants of firm-level import decisions and gaining insight into the mechanisms that facilitate global sourcing is interesting from a policy perspective. Indeed, recent empirical findings demonstrate that intermediates trade is associated with material productivity gains and operates as a vehicle for cross-border knowledge transfers. For example, Goldberg-Koujianou et al. [2010], find that trade liberalisation, via facilitating access to previously unavailable inputs fostered product creation accounting on average for 31% of the new products introduced by Indian firms; In another paper, Halpern et al. [2015], attribute 1/4 of the growth experienced by Hungarian firms between 1993-2002 to imported inputs. Bøler et al. [2015], find that R & D and international sourcing are complementary activities for Norwegian firms, therefore improved access to imported inputs promotes R & D investments and technological change; Kasahara et al. [2016], show that importing increases relative demand for educated workers within each occupation in Indonesia; Blaum et al. [2017b] find that prices of manufacturing products would be 27% higher in France, in the absence of inputs trade.

The study of import spillovers also relates to literature on fixed costs and self-selection into import and export markets.² A well known finding in the international trade literature is that both exporting and importing involve significant upfront fixed entry costs. This is consistent with evidence in favour of self-selection of high performance firms into international activi-

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² The modelling of fixed costs goes back to Roberts et al. [1995]; Roberts and Tybout [1997]; Clerides et al. [1998]; Bernard and Jensen [1999], Melitz [2003] and others.
ties. Firms that are active in international markets (either through importing or through exporting) are different from firms with only domestic activities along several relevant dimensions. They tend to be bigger, generate higher value added, pay higher wages, employ more capital per worker and more skilled workers and have higher productivity.3

A significant part of the fixed costs associated with importing can be thought of as informational transaction costs.4 These include *inter alia* costs related to acquiring information about the availability, the prices, the quality and the technical characteristics of foreign intermediates; demonstrating their compatibility with domestic regulations but also with the firm’s production process and its workers’ skills; identifying potential suppliers and verifying their credentials as well as familiarising with a different business environment and the conditions of contract enforcement in a foreign country.5

The study of spillovers is in general challenging from an econometric point of view. While being exposed to the identification concerns that are inherent to this literature, I believe I come close to providing evidence on import

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3 Mayer and Ottaviano [2007], using firm-level data covering a number of European countries analyse the characteristics of the firms involved in international activities through exports and/or foreign direct investment and establish that such firms are ‘superstars’. Bernard et al. [2003] show that U.S. importers are more than twice as large and about 12% more productive than non-importers. They also establish similar results for exporters, showing that they are significantly larger (by approximately 97% in terms of employment and 108% in terms of shipments); more productive (by roughly 11% for value-added per worker and by 3% in terms of the TFP); pay higher wages (by around 6%) and are relatively more capital- and skill-intensive than non-exporters.

4 This is also true for exporting. Allen [2014], examines how information frictions affect trade. Using data on regional agricultural trade in the Philippines, he shows that information frictions are quantitatively important.

5 Relatedly, in an interview survey of Swedish companies undertaken by the Swedish National Board of Trade Kommerskollegium [2011], 10% of manufacturing firms engaging in international trade stated that Sweden should prioritise the provision of import advice. Moreover, 16% of manufacturing firms engaging in international trade stated that they wanted it to be easier to gather information about different regulatory frameworks. Relatedly another 10% submitted that Sweden should prioritise information networks.
spillovers. Endogeneity concerns are meticulously addressed and my results survive rigorous robustness checks.

A number of interesting and novel findings arise. First, the spillover mechanism is product- and origin-specific i.e. a firm’s decision to incorporate a given foreign intermediate in its production process depends (positively) on the number of established importers of that same product-country pair. I interpret this finding as evidence that import spillovers primarily operate via lowering the product and source-market component of the fixed costs associated with international sourcing. Second, import spillovers between firms operating in the same industry (‘intra-industry’) exhibit spatial decay. An interesting reading of this finding is that easier access to imported intermediates is among the benefits (detailed by Porter [1998]) arising from being located close to other firms in the same industry. Third, I find that spillovers operate via buyer-seller relationships and in particular, via backward linkages. As buyer-seller linkages are not critically determined by distance, no clear pattern of spatial decay emerges for ‘inter-industry’ spillovers. Fourth, my results suggest that firm-level sourcing decisions are primarily influenced by established importers of akin organisational and ownership structure. Last, I find no clear evidence of spillovers on the imported volume.

The remaining of the paper is organised as follows. Section 1.2, conceptualises the spillover mechanism. In Section 1.3, I describe the data and the process of building my working data set. In this section, I also detail the empirical strategy, discuss the caveats and my preferred approach of dealing with estimation concerns. In Section 1.4, I present the results of the estima-
tion and in section 1.5, I summarise the main robustness checks and discuss how baseline results have been affected. Section 1.6 discusses additional results and last; Section 1.7, concludes.

1.2 Conceptualising information spillovers between importers

Final goods production requires firms to determine their 'sourcing strategy' i.e. the set of intermediate product varieties to be used as inputs to their production process, where the term 'variety' refers to an intermediate product \((k)\) and source-market \((c)\) pair, \(j = \{k,c\}\).

Manufacturing firms can satisfy their input requirements locally or source the inputs relevant for production from abroad. In determining its 'sourcing strategy', the firm decides which intermediate products to use as inputs and where to source these products from. Hence, the extensive margin of global sourcing has both a product as well as a source-market dimension.

The distinction between intermediate products and intermediate product varieties assumes that intermediates are differentiated by their country of origin. As a result, manufacturers perceive inputs within the same product class but produced in different countries as being 'imperfect substitutes'. Differentiation occurs along several dimensions and may inter alia relate to quality and embodied technology but also compliance with domestic regulations and compatibility with firm-specific production requirements.\(^6\)

The international trade literature has established that entry into import (and

\(^6\) Consider for example differences regarding compliance with health and safety standards between EU-produced and Chinese fabric dye from the perspective of a French garments manufacturer.)
export) markets is associated with market access costs. In order to engage in international activities, firms incur significant, upfront fixed costs, which are in addition to per-unit costs, such as transport costs and tariffs.

Observed patterns of global sourcing not only are suggestive of such costs but also reveal heterogeneity in fixed sourcing costs by product class and by source market. In Swedish data for example, the median importer sources one product code from a single source market, whereas the top 1% of importers source more than 30 different product codes from as many as 17 distinct markets. Moreover, differences in the performance of importing and non-importing firms increase with the intensity as well as the scope of import activity. In particular, Swedish firms importing more than 10 distinct product-country combinations, are almost 9 times bigger (in terms of output) and almost 6 times bigger (in terms of employment) compared to firms that source a single intermediate product from a single source market.

The bulk of research on fixed costs has focused on verifying their existence and quantifying their magnitude. However, it remains largely unclear what these costs actually entail. We understand that a significant component of market access costs relates to the process of acquiring information relevant to entering a foreign market. Indicatively, Allen [2014], examines how information frictions affect trade. Using data on regional agricultural trade in the Philippines, he shows that information frictions are quantitatively im-

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7 I do not suggest that incorporating domestically produced intermediate inputs is free of such costs. The assumption made here is rather that the fixed costs associated with international sourcing are materially higher.


9 Recently, there have been some attempts to open ‘the black box’ of fixed costs and identify some aspects of fixed export costs e.g. Smeets et al. [2010].
The ‘informational component’ of the fixed costs associated with global sourcing, pertains to gathering information about: the availability, the prices and the quality of foreign intermediates; their technical characteristics and their compatibility with domestic regulations and with the firm’s own production requirements; foreign suppliers; the business environment and the conditions of contract enforcement in the source market.

Importing some intermediate product categories is linked with higher up-front informational requirements. For example, verifying the expertise and the reliability of the supplier and obtaining the necessary certifications, can be more complex, lengthy and costly a process when sourcing ‘state of the art’ technological equipment as opposed to standard mechanical parts.

At the same time, while the contractual environment is in general more transparent in some economies, the fixed costs associated with sourcing intermediate inputs from more accessible countries need not be uniformly low for all intermediate product categories. Factors like the productive structure, the degree of political involvement in different sectors of the economy etc., suggest that fixed costs associated with sourcing different products from the same country may vary.

We can therefore think of the fixed cost associated with sourcing intermediate product variety \( j = \{ k, c \} \), as comprising of both country- and product-specific components.

\[
f_j = \tilde{F} + \tilde{f}_c + \tilde{f}_k + \tilde{f}_j
\]  

(1.1)

\( \tilde{F} \) represents information relating to importing activities in general (regard-
less of the product or source market) such as, familiarising with the domestic customs bureaucracy and document requirements. \( \hat{f}_c \) and \( \hat{f}_k \) are the country- and product-specific components of the import relevant information respectively. Last, \( \hat{f}_j \) encompasses the component of import-relevant information that is specific to an intermediate product variety (i.e., product-country pair).

Import spillovers are perceived here as unintentional exchanges of import-relevant information between existing and prospective importers.\(^{10}\) Following the standard approach in the recent empirical literature on export spillovers, see Koenig [2009]; Koenig et al. [2010]; Choquette and Meinen [2014]; Mayneris and Poncet [2013]; Mayneris and Poncet [2015], the modelling hypothesis is that any knowledge acquired by incumbent importers (i.e., firms that have already incurred the fixed sourcing costs), spills over to non-importers thus lowering their respective fixed costs and facilitating their decision to source from abroad. Hence, the import spillover mechanism renders fixed costs of international sourcing endogenous and decreasing in the number of importers.\(^{11}\)

The precise form of the import spillover mechanism though is unknown. The empirical analysis set out in the following sections, aims to provide evidence on the existence of information spillovers and to unpack their nature. In particular, I seek to provide answers to the following questions:

**How specific is the spillover mechanism?** To the extent that import-relevant

\(^{10}\)I remain agnostic about the incentives of firms on both ends of the informational transaction.

\(^{11}\)In particular, in the theoretical literature on exporter spillovers, the spillover mechanism takes the form of a fixed cost that decreases with the number of exporters. See Krautheim [2013].
information is fully transferrable between products and/or source markets, all information acquired by established importers, regardless of what and where from they import, facilitates prospective importers to start sourcing any intermediate product from any source market. If on the contrary, import relevant information is specific to a product and/or country, import spillovers occur between established importers of a particular intermediate product and/or source-market (pair) and prospective importers of the same intermediate product and/or source-market (pair).

**What are the boundaries of the spillover mechanism?** The ‘Marshallian specialisation thesis’, postulates that knowledge spillovers are stronger within regions with production structures that are specialised towards a particular industry. Hence, informational transfers between firms depreciate with geographic distance and between industries. Consistent with the Marshallian interpretation, the spillover mechanism would be confined within the boundaries of the region-industry cluster where the firm facing the sourcing decision operates. On the other side of the argument we have the ‘Jacobian diversification externalities’ positing that knowledge spillovers are stronger between different industries resulting in diversified production structures being more innovative. In this context, ‘inter-industry linkages’ and in particular, buyer seller relationships enable the diffusion of import-relevant information between firms operating in different industries.

**What is the shape of the spillover mechanism?** Counting the number of firms in a certain region and/or industry to proxy for agglomeration effects is common practice in the urban economics literature (see López and Südekum [2009]). This approach assumes that all incumbent importers regardless of
their characteristics, carry equally relevant information and influence symmetrically the sourcing decisions of their neighbours. Moreover, this formulation assumes that all firms irrespective of their characteristics, are identical in the way they assimilate this information. The empirical analysis will explore whether the characteristics of the firms that engage in either end of the informational transaction (i.e., both the ‘sender’ and the ‘receiver’) affect the nature of the spillover mechanism.

In line with recent empirical evidence on export spillovers, the benchmark assumption employed here is that spillovers operate via lowering the product and source-market component of the fixed sourcing costs and that they are sector- and region-specific.

1.3 Data and empirical design

1.3.1 The Data:

I use a detailed data set provided by Statistics Sweden (S.C.B.) monitoring the universe of Swedish firms (i.e., all the firms featuring in the Companies’ Registry) over a period of 15 years (from 1997 to 2011). Each firm is identified by a unique reference number and is linked to its sub-units12 via unique identifiers. The data set is rich in information about the firm’s activities (e.g. industry classification), its location (at the finest administrative level i.e. the municipality -kommun-), its characteristics (ownership category, legal form etc.) as well as its scale and performance (number of employees, value of output produced, net value added, labour costs, input costs etc.). The data

12 I.e. its plants if it is a multi-plant firm.
also contains information on the firms' import and export activities, detailing both the value and the volume traded and specifying the traded product codes\textsuperscript{13} and source/destination markets.

I clean the data for inconsistencies. I drop firms with gaps in their observed histories,\textsuperscript{14} firms declaring negative sales and firms reporting negative/zero employment levels\textsuperscript{15} at any point of their history. Additional restrictions include dropping the firms/plants that change location and/or industry over the time period covered. This allows me to avoid dealing with more confounding factors associated with firms' endogenous change of location or activity.

Notwithstanding its wealth, the data does not allow me to observe purchases of domestically produced intermediates at the product-level or indirect imports, i.e., purchases of imported intermediates from trade intermediaries. These transactions are bundled under general input costs in the firm's balance sheet accounts. My analysis will therefore focus on how spillovers affect firm-level decisions to import intermediates rather than the effect of spillovers on purchases of intermediates in general. The effort required to gather information about the availability, the prices and the characteristics of foreign intermediate product varieties is arguably greater compared to the

\textsuperscript{13}Product classification follows the Combined Nomenclature of the European Union (CN8), which integrates the HS nomenclature (i.e., the Harmonised System consisting of 5,000 distinct product categories identified by 6-digit codes) and comprises additional 8-digit subdivisions. I round up the product codes to a 4-digit nomenclature which is sufficiently detailed and more stable. I am left with 1,250 distinct codes down from 13,937.

\textsuperscript{14}I wouldn't be able to identify the time period a firm starts to import a particular product-country pair in the presence of gaps.

\textsuperscript{15}Negative employment, like negative sales are clearly incidents of misreporting. There is a limited number of firms that register negative sales in the time frame covered and no firms registering negative employment. There are however many firms with zero employees. In theory, these are firms run by the owner. The reason for this restriction is that these firms may in fact be shadow firms set up for tax avoidance reasons or ancillary activities.
respective effort required in order to gather information for domestic ones. As a result, spillovers are likely to be more relevant for international rather than domestic sourcing.

In order to limit the presence of resellers and processing trade in the data, the analysis will focus exclusively on manufacturing firms and on the product codes corresponding to broad economic classification categories (BEC) 2 and 4 (i.e. industrial supplies and capital goods).\(^\text{16}\) Manufacturing firms represent c.7% of the firms in the Registry data, whereas after dropping products not falling within the two aforementioned categories I am left with 891 unique product codes (down from 1,250).

Moreover, I drop imports of intermediate varieties that are likely to be globally supplied by a unique producer.\(^\text{17}\)

Import-export data are at the firm level, matching each transaction with the identification number of the importing firm, without however specifying the exact establishment to which imports are destined. Since the agglomeration variables are defined in the vicinity of the establishment facing the import decision, this clearly poses a problem with multi-plant firms. Therefore, the baseline analysis will focus on the sourcing decisions of single-plant firms.

In addition, I focus on the import decisions of Swedish-owned firms, on the grounds that the determinants of foreign firms’ import behaviour may be materially different as these firms are likely to be more integrated with

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\(^{16}\) This is consistent with Halpern et al. [2015]. These categories correspond to intermediate products. I have used Eurostat’s Reference And Management Of Nomenclatures (RAMON) conversion tables to map the CN8 product codes in the Statistics Sweden data to the respective 2-digit product classification categories.

\(^{17}\) I identify these instances as transactions where all firms in Sweden import a product from a single country.
global markets through their parent firm. What is more, from a data perspective, I wouldn’t be able to distinguish between imports and intra-group purchases from the parent or other affiliates based abroad. This is also true for Swedish-owned international firms.

Note however that I allow multi-plant, foreign-owned and Swedish-owned international firms to influence their neighbours’ sourcing decisions by accounting for them in the construction of the spillover variables.

In the working data set, I observe the import histories of approximately 13,500 firms importing 844 distinct product codes from 152 source markets, or 15,576 distinct intermediate varieties (i.e. product-country combinations).\(^{18}\)

1.3.2 Empirical strategy

Firm \(i\), operating in the region-industry cluster \(\{r, s\}\), will include intermediate product variety \(j\) i.e. product \(k\) from source market \(c\) in its sourcing strategy, if and only if the respective profits accruing to the firm are non-negative. In a standard ‘Armington-style’ theoretical framework where the firm’s production function features ‘love for variety’, international sourcing on the input side operates as a vehicle to reduce the variable cost of production.\(^{19}\) Variable cost savings translate into lower prices for the firm’s output. If consumer demand is sufficiently elastic, lower prices will bolster demand for the firm’s output and increase sales revenue.

The additional revenue accruing to the firm is expected to depend inter alia

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\(^{18}\) All the steps towards building the working data set are specified in the Data Appendix.

\(^{19}\) Ethier [1982] introduces ‘love for variety’ into the production function of manufacturers.
on firm-characteristics, product attributes and the competitive conditions in the local market (i.e. the capacity of the market to absorb the firm’s output as well as the level of competition faced by the firm). On the other hand, trade frictions, i.e., both variable as well as fixed costs of sourcing, weigh negatively on the firms’ international sourcing decisions.

The firm-level global sourcing decision is therefore summarised by the following trade-off:

\[
\Delta r_i^{(rs)jt} = \Delta r_i^{(rs)jt} - f_j (N_{rsjt}) \geq 0
\]

(1.2)

According to Equation (2.24), firm \( i \) will start importing intermediate product variety \( j \) at time \( t \), if and only if the additional revenue accruing to that firm from including \( j \) in its sourcing strategy set (\( \Delta r_i^{(rs)jt} \)) at least outweighs the incremental fixed cost \( f_j (N_{rsjt}) \) that the firm has to incur in order to import variety \( j \).

In Equation (2.24), the fixed costs associated with importing intermediate product variety \( j \) are expressed as a function of \( N_{rsjt} \), the number of importers of intermediate product variety \( j \) in region-industry cluster.

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20 Recent advances in the literature on the extensive margins of global sourcing show that the marginal gain from incorporating an additional element in the firm-level sourcing strategy depends on the number and the attributes of all the elements in the firm’s sourcing strategy. See Antrás et al. [2017]. In their paper, the sourcing strategy is defined as the set of source markets the firm imports from. The bundle of production relevant intermediates is fixed and contains a continuum of measure one of firm-specific inputs.

21 Firm \( i \) is bound to a region-industry cluster \( \{r,s\} \) as firms that switch region and/or industry classification have been dropped from the data. Thereby specifying the region and industry alongside the firm in the firm-level measures is superfluous. Hence in the notation, \( r \) and \( s \) appear in parenthesis. I do not completely drop the region- and industry-specific notation so as to map firm-level measures to the respective region and industry measures linked to the cluster where the firm operates.

22 \( \Delta r_i^{(rs)jt} = r_i^{(rs)jt} - r_i^{(rs)(j-1)} \) where \( r_i^{(rs)jt} \) is the revenue of firm \( i \) with sourcing strategy \( \Gamma_{ij} = \{1,2,3,...,j-1\} \cup j \) and \( r_i^{(rs)(j-1)} \) is the revenue of firm \( i \) with sourcing strategy \( \{1,2,3,...,j-1\} \).
{r,s} at time t. Though the exact form of this relationship is not specified, the modelling assumption behind this formulation is that the spillover mechanism takes the form of a variety-specific fixed cost $f_j$ that decreases with $N_{rsj}$. In accordance with the ‘Marshallian specialisation thesis’, spillovers are assumed to be confined within the boundaries of the region and industry cluster.

As market entry costs are thereafter sunk, to differentiate between ‘starters’ and ‘continuers’ the estimation will focus on switches in the firm’s import status with respect to a given intermediate product variety $j$ (i.e., on ‘import starts’). Using Equation (2.24), the probability that $i$ will start importing intermediate product variety $j$ at time $t$ is:

$$\Pr(h_{i(rs)jt} = 1) = \Pr(\Delta r_{i(rs)j} - f_j(N_{rsj}) > 0)$$ (1.3)

$h_{i(rs)jt}$ in (1.3) is an indicator variable that takes the value 1 when a firm takes up importing intermediate product variety $j$ at time $t$ (i.e. if it imports $j$ at time $t$ but not at time $t - 1$) and $h_{i(rs)jt} = 0$ if $i$ does not import $j$ neither in the current nor the previous period. Observations for continuing importers and observations for firms that were importing $j$ at time $t - 1$ but no longer at time $t$ are coded as missing.23

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23 The import history of firm $i$ with respect to any intermediate product variety $j$ over the time period $[1,T]$ is summarised by a sequence of zeroes (if firm $i$ does not import intermediate product variety $j$ at time $t \in [0,T]$) and ones (if $i$ imports $j$ at time $t \in [1,T]$). To fix ideas, if the firm-level import history with respect to intermediate product variety $j$ is represented by the following sequence $\{0,0,1,1,0,0,1,1,1\}$, then the firm’s history of import starts with respect to intermediate product variety $j$ is $H_{i(rs)jT} = \{h_{i(rs)jt}\}_{t=1}^{T} = \{0,0,0,0,1,1,1\}$. (where $T = 11$).
The spillover variable is defined as:

\[
\text{Spill}_{irsjt} = N_{rsjt} - \text{import\_status}_{i(rs)jt}
\]  

(1.4)

where \( \text{import\_status}_{i(rs)jt} \) is a binary variable that takes the value one if firm \( i \), operating in \( \{r,s\} \) imports variety \( j \) at time \( t \) and zero otherwise. \( \text{Spill}_{irsjt} \) therefore counts the number of other importers of variety \( j \) in \( \{r,s\} \).

Ceteris paribus, the same intermediate product variety will induce greater marginal cost savings the more productive the firm. For higher productivity firms, the inequality in (2.24) is therefore more likely to be satisfied with respect to any intermediate product variety \( j \), which in turn implies that more productive firms have a higher probability of importing any \( j \).

This is consistent with the empirical findings in the literature, providing evidence in favour of a selection mechanism of high performance firms into international activities. Firms that are active in international markets (either through importing or through exporting) are materially different from firms with only domestic activities along several dimensions. They tend to be bigger, generate higher value added, pay higher wages, employ more capital per worker and more skilled workers and have higher productivity.\(^{24}\) At the same time, more productive firms are more likely to self select themselves to denser areas\(^{25}\) since they are better equipped to survive the tougher competition. Not accounting for firm-level productivity risks overestimating the importance of spillovers on firm-level international sourcing decisions.

Exporters are more integrated in international markets and have more expe-

\(^{24}\) See Mayer and Ottaviano [2007] and Bernard et al. [2003].
\(^{25}\) Baldwin and Okubo [2006] and Melitz and Ottaviano [2008].
rience in cross-border transactions. A firm exporting to country $c$ may enjoy easier access to information related to sourcing any intermediate product variety from that market and would thereby be more likely to start sourcing from that market for reasons unrelated to the spillover mechanism. In the same vein, firms that form part of business groups enjoy better reputation, better access to finance, and increased bargaining power. As a result, they are more likely to engage in international activities (either importing or exporting).

To account for firm characteristics that influence firm-level sourcing decisions, I augment (1.3) with $\text{Firm}_{i(r)st}$, which is a vector of firm controls.

$$\text{Firm}_{i(r)st} = [\text{Productivity}_{i(r)t} \quad \text{Exporter}_{i(r)ct} \quad \text{BG}_{i(r)t}]'$$ (1.5)

I measure productivity as the value added per worker at time $t$. $\text{Exporter}_{i(r)ct}$ is a binary variable indicating whether firm $i$ is present in the source market of intermediate product variety $j$ as an exporter and; $\text{BG}_{i(r)t}$, is a binary variable indicating whether the firm is affiliated with a (Swedish) business group.

Aitken et al. [1997], note that evidence of spillovers is observationally equivalent to agglomerations arising from exogenous site-specific characteristics. Observed and unobserved characteristics of locations such as, natural advantages (e.g. proximity to the border or the sea) and advantages related to the local infrastructure (e.g. transportation networks, proximity to ports and/or airports, availability of logistic facilities, propinquity to government services, the presence of universities etc.) turn some locations more attrac-

\footnote{Affiliates are less likely to be liquidity constrained and hence more able to cover the fixed costs related to exporting and/or importing.}
tive to firms. In this context, if the agglomeration of import activity is just a consequence of the agglomeration of economic activity, failing to account for the area’s economic importance and innate characteristics risks over-interpreting the importance of agglomeration effects on the firms’ import behaviour in the data. Indeed, as it can be seen in Figure 1.1, the geographic concentration of import activity follows a similar pattern as the concentration of economic activity in Sweden.

In the same vein, some industries are more dependent on technologies that use intensively foreign intermediates. This is illustrated in Figure 1.2, which features the intermediate import dependency by sector, in the Swedish economy.

In light of these patterns, it is important to account for the relative size of the region-industry cluster by including a measure of the region's industrial concentration. What I aim to capture is import spillovers, rather than the fact that firms operating in a region-industry cluster are likely to have similar input requirements and hence, akin sourcing behaviour. For example, Stockholm is a leading centre in the production of telecommunications equipment. Firms located in Stockholm are therefore more likely to import, or to start importing, products that are intensively used as inputs in that industry for reasons reflecting the regional specialisation in communications technology, rather than the effect of import spillovers.

It is essential to keep in mind that agglomeration effects involve positive market (e.g., cost sharing) and non-market externalities (e.g., informational exchanges); negative externalities (e.g., congestion of logistic facilities, customs bureaucracies etc.) and competition. However, disentangling these
Figure 1.1: Distribution of economic activity (left) and import activity (right), by country, 2011.

Source: Data from Statistics Sweden.
Regional concentration of activity is measured by the number of firms in the area.
effects and isolating the role of import spillovers, defined here as informational transactions between existing and prospective importers, is not unequivocal. The estimation can in fact only capture the net effect of the forces in play. Including a measure of competition in Equation (1.3), helps me limit the scope for interpreting the estimated coefficients.

The regional market’s capacity to absorb firm i’s additional output (in response to lower production costs associated with the expansion of its sourcing strategy) is positively related to the level of economic activity. To account for this, I include in Equation (1.3) the region’s working population as a proxy for economic activity. Moreover, employees are ‘carriers’ of business-relevant information that is diffused through casual and professional inter-
Taking note of these considerations, I augment Equation (1.3) with $Demand_{rst}$, a vector of region and industry controls:

$$Demand_{rst} = \begin{bmatrix} Ind_{conc_{rst}} & HHI_{rst} & Empl_{rst} \end{bmatrix}$$ \hspace{1cm} (1.6)

$Ind_{conc_{rst}}$ is a measure of the region's industry concentration defined as $r'$s share of industry $s$' activity normalised by the region's share of manufacturing activity.\footnote{Following Aitken et al. [1997].} $HHI_{rst}$ is the Herfindahl-Hirschman index (HHI),\footnote{It is defined as the sum of the squares of the market shares (expressed in fractions) of the firms within the industry. Its calculation is sometimes limited to the 50 largest firms. Its values can range from close to zero to 10,000.} a widely accepted measure of market concentration (i.e., a measure of the size of firms in relation to the industry) and an indicator of the amount of competition in the market. In particular, the value of the HHI is inversely related to the strength of competition in the market. $Empl_{rst}$ stands for the number of workers employed by firms operating in the region and industry cluster \{r, s\}.

The S.C.B. dataset does not have price data. The price variable here is constructed as the total value of product-country specific imports for a given firm, divided by the weight of the respective transaction.\footnote{Acknowledging that weight is not the appropriate unit for some products.}

I further include in (1.3), the source market's GDP as well as Sweden's total imports of intermediates from that country in order to account for bilateral trade relationships (reflecting \textit{inter alia} the relative position of the two countries in a value chain, the source market's comparative advantage etc.).
In addition, I augment Equation (1.3) with firm-product-source market fixed effects ($\delta_{i(ras)}$). The firm dimension of the fixed effects captures time-invariant, observed and unobserved heterogeneity reflecting inter alia differences in managerial quality, organisation, ownership structure and reputation.\textsuperscript{30} It will further account for the time invariant observed and unobserved characteristics of the region and industry cluster where the firm operates since I have dropped firms that have changed location and/or sector over the period covered. Respectively, time invariant characteristics that are specific to the firm’s location and the source market, such as lower trade costs due to shorter distances or historical and cultural ties etc.,\textsuperscript{31} will be absorbed by the firm-country dimension of the fixed effects. The firm-product dimension picks up time invariant aspects of the region’s specialisation patterns.

I also include in Equation (1.3) year effects and year effects with a region and industry ($t \times \delta_{ras}$) as well as with a product-source market ($t \times \delta_{j}$) dimension. Year effects absorb shocks that are common to all firms, across industries and regions such as, the 2007 financial crisis, the Euro Area debt crisis in 2010, or other economy-wide macroeconomic shocks.

Year effects with a region and industry dimension, will address shocks that asymmetrically affect a region (e.g., natural disaster, regional reform etc.) and/or a sector (e.g., sector-specific reform). Spillovers on firm-level sourcing decisions are then identified on the variation of import switches across intermediate product varieties within a given region and industry cluster.

\textsuperscript{30}If unobserved characteristics vary over time then assuming that they are orthogonal to other firms’ import decisions would alleviate concerns about them affecting the coefficient of spillovers.

\textsuperscript{31}For example, the south of Sweden can be thought of as having a natural advantage in doing business with Denmark.
Shocks affecting the supply capacity of producers of intermediate input \( k \) in country \( c \), e.g., a new aggressive trade union leadership organises a prolonged strike, would influence sourcing decisions of Swedish firms regardless of their location or industry evenly. The inclusion of source-market-product-year effects should therefore account for the endogeneity threats posed by such shocks. Spillovers are then identified on the variation of import switches across region and industry clusters within a given product-source market pair and year. Source-market-product-year effects would also control for shocks of lower dimensions i.e. shocks that affect a particular product (e.g., the discovery of a new production method) or shocks that are specific to a particular source-market (e.g., the Fukushima earthquakes in Japan in 2010 that severely disrupted Japan’s economic activity).

The direction of the relationship between a firm’s decision to start importing and the firm’s productivity is not straightforward. The literature on imports provides evidence both in favour of a selection mechanism whereby only the most productive firms are able to cover the fixed costs associated with sourcing intermediates from abroad; but is also supportive of a ‘learning by importing’ mechanism whereby firms that engage in international sourcing experience productivity gains.\(^{32}\)

Similar concerns arise with respect to other firm characteristics.\(^{33}\) Reverse causality could also be an issue with respect to the spillover variables, as a

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\(^{32}\) See Goldberg-Koujianou et al. [2010]; Halpern et al. [2015]; Bøler et al. [2015]; Kasahara et al. [2016].

\(^{33}\) Are firms that export to country \( c \) more likely to start importing intermediates from that country, or is it that importing from a given source market makes it also easier to export there? In the same vein, is it easier for firms that form part of business groups to cover fixed costs of sourcing and start importing foreign intermediates, or is it that firms that import become more likely ‘targets’ to be acquired by business groups.
result of the ‘reflection problem’ permeating the literature on peer effects. To address this concern, all right hand side variables in the estimated equation are lagged by one period.

1.3.3 Empirical model

Equation (1.3) becomes:

\[
\Pr(h_{i(rs)jt} = 1) = \Pr(\alpha_1 Firm_{i(rs)t-1} + \alpha_2 Demand_{rs t-1} + \alpha_3 price_{i(rs)jt-1} \\
+ \alpha_4 Spill_{irsjt-1} + \alpha_5 GDP_{ct-1} + \alpha_6 Imports_{ct-1} \\
+ \delta_i + t + t \times \delta_j + t \times \delta_{rs} + \epsilon_{i(rs)jt} > 0)
\]

(1.7)

Provided that (1.7) can be written as:

\[
\Pr(h_{i(rs)jt} = 1 | X_{i(rs)jt-1}) = \Lambda(X'_{i(rs)jt-1} \alpha + \delta_i + t + t \times \delta_j + t \times \delta_{rs} + \epsilon_{i(rs)jt})
\]

where \(X_{i(rs)jt}\) is the vector of covariates;

\[
X_{i(rs)jt} = [Firm_{i(rs)t} \quad Demand_{rs t} \quad price_{i(rs)jt} \quad Spill_{irsjt} \quad GDP_{ct} \quad Imports_{ct}]
\]

\(\alpha\) is the vector of coefficients and \(\Lambda(\cdot)\) is the logistic cumulative distribution. It can be estimated with a fixed effects logit. The estimation captures the relationship between changes in the spillover variable over time (with respect to the average level of agglomeration over the entire period) and the firm’s decision to start importing any given intermediate product variety. All non-binary variables, with the exception of the spillover variable are expressed in logarithms. Spillover variables are expressed in levels.

For the regional disaggregation I use ‘Labour Areas’. There are 86 labour areas in Sweden, which are defined according to commuting patterns of em-
ployees, rather than administrative borders. The industrial disaggregation is the 2-digit NACE level.

1.4 Results

1.4.1 Identifying spillovers on firm-level sourcing decisions

Columns (1) to (5) in Table 3.1, report the estimation results as I gradually add more controls to build the baseline specification in equation (1.7). In the first column only the spillover variable is included in the controls. The specification in column (2), adds firm controls. Column (3) introduces region and industry controls. Column (4) further accounts for the variety’s firm-specific price. The source market controls are included in Column (5), which will be referred to as the baseline (or preferred) specification.

The coefficient on the spillover variable is positive and highly significant and remains stable and highly significant across specifications. In the preferred specification, one additional importer of intermediate product variety \( j \) in the region-industry cluster \( \{r, s\} \) is associated with an 1 percentage point increase in the probability that firm \( i \) operating in \( \{r, s\} \) takes up importing intermediate product variety \( j \) at time \( t \).34 This is a substantial impact considering that there are approximately 400,000 active firm-product-country trade links per year.35

---

34 Following Train 2009, the marginal effect in terms of p.p. changes of probability can be calculated as \( 0.01 = 0.0896 \times 0.88 \times (1 - 0.88) \), where .88 is the average probability of starting to import any intermediate product variety \( j \) at time \( t \). Note that .88 is the average probability of starting to import in the working data set, not the unrestricted data. Alternatively, an increase of one standard deviation in the number of same variety importers operating in the firm’s region and industry cluster (2.8) is associated with an increase of c.3% in the probability that any firm starts importing any intermediate product variety.

35 See Table A.2.
Firm-level characteristics enter with the expected sign and are significant (at the 1% level). More productive firms are more likely to start importing any product-country pair at any given time $t$. In particular, a 1% increase in productivity is associated with a 2 percentage points increase in the probability to start sourcing any variety $j$. Exporters and firms that are affiliated with business groups are 3.9 and 1 percentage points more likely to start importing any intermediate product variety $j$ at time $t$.

The coefficient on the region’s size, measured by the size of the local labour pool (i.e., the number of employees), has a positive sign but is not significant. The economic relevance of the region-industry cluster, as it is accounted for by the industrial concentration variable, is significant but only at the 10% significance level. The coefficient on HHI (inverse measure of competition) is negative and significant at the 1% level. More intense competition encourages firms to start sourcing any intermediate product variety. Not surprisingly, the coefficient on the variety’s price is negative and highly significant. In particular, a 1% increase in price is associated with a 1.4 percentage points decrease in the probability of starting to import that variety. The coefficient on the trade partner’s GDP is positive and highly significant in line with the gravity theory predictions. A 1% increase in the trade partner’s GDP implies a 6.6% increase in the probability that any firm will start sourcing (any) intermediate product from that country. A 1% increase in Sweden’s total imports of intermediates from that country implies an increase of 3.4 percentage points in the probability that any firm will start sourcing intermediates from that country. The results reported in Table 3.1 are suggestive of a positive relationship between the agglomeration of same-variety importers in the region-industry cluster and firm-level sourcing.
### Table 1.1: Identifying import spillovers

<table>
<thead>
<tr>
<th>Variables</th>
<th>Column (1)</th>
<th>Column (2)</th>
<th>Column (3)</th>
<th>Column (4)</th>
<th>Column (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spillover measures</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( Spillover_{jt-1} )</td>
<td>0.0962***</td>
<td>0.0957***</td>
<td>0.0951***</td>
<td>0.0906***</td>
<td>0.0896***</td>
</tr>
<tr>
<td></td>
<td>(0.0048)</td>
<td>(0.0048)</td>
<td>(0.0048)</td>
<td>(0.0049)</td>
<td>(0.0048)</td>
</tr>
<tr>
<td>Firm controls</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( Productivity_{it-1} )</td>
<td>0.1877***</td>
<td>0.1847***</td>
<td>0.1862***</td>
<td>0.1832***</td>
<td>0.1832***</td>
</tr>
<tr>
<td></td>
<td>(0.0119)</td>
<td>(0.0119)</td>
<td>(0.0129)</td>
<td>(0.0129)</td>
<td>(0.0129)</td>
</tr>
<tr>
<td>( Exporter_{it} )</td>
<td>0.4224***</td>
<td>0.4220***</td>
<td>0.3885***</td>
<td>0.3719***</td>
<td>0.3719***</td>
</tr>
<tr>
<td></td>
<td>(0.0151)</td>
<td>(0.0151)</td>
<td>(0.0152)</td>
<td>(0.0162)</td>
<td>(0.0162)</td>
</tr>
<tr>
<td>( BG_{it} )</td>
<td>0.1093***</td>
<td>0.1078***</td>
<td>0.1022***</td>
<td>0.1057***</td>
<td>0.1057***</td>
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<td>(0.0185)</td>
<td>(0.0185)</td>
</tr>
<tr>
<td>Region &amp; industry controls</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( Empl_{it-1} )</td>
<td>0.0662</td>
<td>0.0508</td>
<td>0.0474</td>
<td></td>
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<tr>
<td></td>
<td>(0.0598)</td>
<td>(0.0642)</td>
<td>(0.0645)</td>
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<td></td>
</tr>
<tr>
<td>( HHI_{it} )</td>
<td>-0.0001***</td>
<td>-0.0001***</td>
<td>-0.0001***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.0000)</td>
<td>(0.0000)</td>
<td>(0.0000)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( Ind_{conc, it} )</td>
<td>0.0579***</td>
<td>0.0458*</td>
<td>0.0452*</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>(0.0166)</td>
<td>(0.0180)</td>
<td>(0.0180)</td>
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</tr>
<tr>
<td>Variety characteristics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( price_{it} )</td>
<td>-0.1196***</td>
<td>-0.1181***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.0225)</td>
<td>(0.0226)</td>
<td></td>
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</tr>
<tr>
<td>Source-market characteristics</td>
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<td></td>
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</tr>
<tr>
<td>( GDP_{it} )</td>
<td>0.6396***</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td>(0.0641)</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Imports_{it}</td>
<td>0.3173***</td>
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</tr>
<tr>
<td></td>
<td>(0.0239)</td>
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<td></td>
</tr>
<tr>
<td>Firm-Product-Country FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year FE x Product-Country FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year FE x Region-Industry FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td># Observations</td>
<td>651,132</td>
<td>650,919</td>
<td>650,919</td>
<td>538,830</td>
<td>536,655</td>
</tr>
<tr>
<td># triads (firm-product-country)</td>
<td>71,695</td>
<td>71,675</td>
<td>71,675</td>
<td>62,824</td>
<td>62,623</td>
</tr>
<tr>
<td>pseudo R-squared</td>
<td>0.008</td>
<td>0.011</td>
<td>0.011</td>
<td>0.011</td>
<td>0.013</td>
</tr>
</tbody>
</table>

Notes: Fixed effects logit on the decision to start importing intermediate product variety \( j \). Standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All right hand side variable are lagged (by one period). Non-binary variables are expressed in logarithms. Spillover variables are in levels.
decisions.

1.4.2 The nature of import spillovers

1.4.2.1 How specific is the spillover mechanism?

In this section, I investigate the specificity of the spillover mechanism. Table 1.2, examines the predominance of the spillover mechanism’s product-and-origin component by exploring whether the effect persists if (other) incumbent importers in the region and industry cluster source different product codes and/or source from different source markets.

The total number of (other) importers in the region-industry cluster ($Spill_{irsjt}$) is decomposed into four non-overlapping spillover measures: $Spill_{irsjt}$ is the benchmark spillover variable as defined in (1.4). It counts the number of (other) firms in $\{r,s\}$ importing the same intermediate product variety $j = \{k,c\}$, i.e. the same product $k$ from the same source market $c$;

$Spill_{irskct} = \sum_{c'x} \left( N_{rskct} - \text{import\_status}_{i(rs)k'} \right)$ is the number of (other) firms importing the same product $k$ from any different source market $c'$;

$Spill_{irskc't} = \sum_{k'x} \left( N_{rskc't} - \text{import\_status}_{i(rs)}k' \right)$ is the number of (other) firms importing any different product $k'$ from the same source-market $c$ and

$Spill_{irskc'ct} = \sum_{c'x} \sum_{k'x} \left( N_{rskc'ct} - \text{import\_status}_{i(rs)k'} \right)$ is the number of (other) firms importing any different product $k'$ from any different source market $c'$.

$$Spill_{irsjt} = Spill_{irsjt} + Spill_{irskc't} + Spill_{irskc't} + Spill_{irskc'ct}$$ (1.8)

All the different measures of spillovers are highly significant however, the order of magnitude of the respective coefficients suggests that the spillover
mechanism operates primarily via the product- and country-specific component of the fixed costs. Hence, the assumption behind the baseline formulation in (1.4), i.e. that the spillover mechanism is variety-specific, is upheld. We can therefore say that the probability that firm $i$ in $\{r,s\}$ starts importing any given variety $j$ at time $t$ increases with the number of same variety importers operating in $\{r,s\}$ rather than with the number of importers in general i.e. firms sourcing different product-country combinations.

<table>
<thead>
<tr>
<th>Table 1.2: Identifying import spillovers</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Spill_{r^{j}i^{t-1}}$</td>
</tr>
<tr>
<td>$Spill_{r^{sk}c^{t-1}}$</td>
</tr>
<tr>
<td>$Spill_{r^{sk}c^{t-1}}$</td>
</tr>
<tr>
<td>$Spill_{r^{sk}c^{t-1}}$</td>
</tr>
<tr>
<td>Full controls</td>
</tr>
<tr>
<td>Firm-Product-Country FE</td>
</tr>
<tr>
<td>Year FE</td>
</tr>
<tr>
<td>Year FE×Product-Country FE</td>
</tr>
<tr>
<td>Year FE×Region-Industry FE</td>
</tr>
<tr>
<td># Observations</td>
</tr>
<tr>
<td>#triads (firm-product-country)</td>
</tr>
<tr>
<td>pseudo R-squared</td>
</tr>
</tbody>
</table>

Notes: Fixed effects logit on the decision to start importing intermediate product variety $j$. Standard errors are reported in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. All right hand side variable are lagged (by one period). Non-binary variables are expressed in logarithms. Spillover variables are in levels.

The coefficients on $Spill_{r^{sk}c^{t}}$ and $Spill_{r^{sk}c^{t}}$ are negative. The spillover mechanism affects firm-level sourcing decisions by affecting the trade-off summarised in (2.24). All else equal, import spillovers render widely used varieties more ‘appealing’ by lowering their respective access costs. As a result of spillovers being product-and origin-specific, prospective importers
in the region-industry cluster \{r,s\} are more likely to start importing the same intermediate product variety as their neighbours rather than the same intermediate product from a different source market or a different product from a different source market.\(^{36}\)

\[1.4.2.2 \text{ The boundaries of the spillover mechanism}\]

Consistent with the ‘Marshallian specialisation thesis’, the benchmark modelling of the spillover mechanism in (1.4) assumes that informational transfers between firms fully depreciate when extending beyond the boundaries of the region-industry cluster. On the other hand, ‘Jacobian diversification externalities’ posit that knowledge spillovers are stronger between different industries.

There is indeed increased scope for relevant informational transfers between firms operating in the same industry (regardless of location) as these firms share similar technology, are often members of the same business associations, hire employees from the same pool of workers \textit{et cetera}. On the other hand, inter-industry linkages and in particular, buyer-seller relationships also facilitate the exchange of information between firms operating in upstream/downstream industries. One possible channel, is that information about new inputs, their characteristics and the difficulties of international sourcing is enabled by regular interactions between the employees of firms connected with a ‘buyer-seller’ link. Another possible explanation is that the

\(^{36}\)In interpreting the sign of the coefficient we should also remind ourselves that what is being captured by the estimation process is the ‘net’ effect of positive market and non-market externalities, competition and congestion. Hence, the negative coefficient on these spillover measures may also suggest that competition and congestion effects override any positive information externalities, possibly because the scope for the latter is smaller as we move away from the product- and country-specific component.
very nature of buyer-seller relationships is conducive to gaining insight into other firms’ technologies and the inputs to their production.

While physical proximity can be expected to assist the dissemination of import-relevant information both ‘inter-industry’ and ‘intra-industry’ linkages extend beyond the regional boundaries. This section explores the relative importance of regional ties versus inter- and intra-industry linkages.

In Table 1.3, I investigate the boundaries of the spillover mechanism by exploring whether the effect persists if incumbent importers of intermediate product variety \( j \) operate in a different region-industry cluster than the firm facing the sourcing decision. The total number of importers of variety \( j \) (across regions and industries) is therefore decomposed in four non-overlapping measures.

\[
\text{Spill}_{ijt} = \text{Spill}_{irsjt} + \text{Spill}_{ir'sjt} + \text{Spill}_{irs'jt} + \text{Spill}_{ir's'jt} 
\]

\( \text{Spill}_{irsjt} \) is the benchmark spillover measure defined in (1.4); \( \text{Spill}_{ir'sjt} = \sum_{r'as} N_{irs'sjt} \) stands for the number of importers of \( j \) operating in the same industry (as firm \( i \)) but located in a different region; \( \text{Spill}_{irs'jt} = \sum_{s'as} N_{irs'jt} \) counts the number of importers of \( j \) located in the same region (as \( i \)) but operating in a different industry and; \( \text{Spill}_{ir's'jt} = \sum_{r'as} \sum_{s'as} N_{ir's'jt} \) counts the number of importers of intermediate product variety \( j \) located in a different region and operating in a different industry.

In Column (2), I include both the benchmark spillover variable, counting the number of same variety importers in the firm’s region and industry and the

\[37\text{It is for example reasonable to assume that it is easier to observe the import behaviour of neighbours. Moreover, it can be expected that exchanges of firm-specific knowledge via casual or business interactions between employees are intensified with physical proximity as in Bernard et al. [2015].}\]
Table 1.3: The boundaries of the spillover mechanism

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>( Spill_{ir,j,t-1} )</td>
<td>0.0895***</td>
<td>0.0832***</td>
<td>0.0844***</td>
<td>0.0502***</td>
<td>0.0497***</td>
</tr>
<tr>
<td></td>
<td>(0.0048)</td>
<td>(0.0049)</td>
<td>(0.0049)</td>
<td>(0.0051)</td>
<td>(0.0051)</td>
</tr>
<tr>
<td>( Spill_{ir,j,t-1} )</td>
<td>0.0330***</td>
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</tr>
<tr>
<td></td>
<td>(0.0031)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( Spill_{ir,j,t-1} )</td>
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<td>0.0279***</td>
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</tr>
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<td></td>
<td></td>
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<tr>
<td>( Spill_{ir,j,t-1} )</td>
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Channel Variables

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<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
</tr>
</thead>
<tbody>
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<td></td>
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<tr>
<td></td>
<td>(0.0348)</td>
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<td>backward (same region, t-1)</td>
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<tr>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year FE x Product-Country FE</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Year FE x Region-Industry FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

# Observations                  | 536,655   | 536,655   | 536,287   | 536,287   | 536,655   |
Adjusted R-squared              | 0.013     | 0.013     | 0.013     | 0.016     | 0.017     |

Notes: Fixed effects logit on the decision to start importing intermediate product variety \( j \). Standard errors are reported in parentheses. *** \( p<0.01 \), ** \( p<0.05 \), * \( p<0.1 \). All right hand side variable are lagged (by one period). Non-binary variables are expressed in logarithms. Spillover variables are in levels.
number of same variety importers in the firm’s region but operating in different industries. Together, $Spill_{ijrst}$ and $Spill_{ijsrst}$ account for all importers of intermediate product variety $j$ in the region. The coefficients on both the intra- and the inter-industry spillover measures are positive and highly significant at the 1% confidence level. The spillover effect arising from firms in the same industry is however stronger. One additional importer of variety $j$ operating in $\{r, s\}$ is associated with an increase of 0.8%, in the probability that any firm $i$ in $\{r, s\}$ will start importing $j$ whereas one additional importer of variety $j$ operating in $\{r, s’\}$, $s \neq s’$ is associated with an increase of only 0.3%, in the probability that any firm $i$ in $\{r, s\}$ will start importing $j$.

The literature on inter-industry interactions makes the distinction between backward linkages (i.e. linkages between a firm and its customers) and forward linkages (i.e., linkages between a firm and its suppliers). The former type comes across as an important channel for export spillovers arising from the presence of multinational firms in Kneller and Pisu [2007]; as well as for productivity spillovers arising from multinational firms as documented in Javorcik [2004]. Choquette and Meinen [2014] also find that backward linkages are an important channel for the transmission of country-specific export-relevant information among firms.

The importance of inter-industry linkages as a channel through which import spillovers operate is explored in Columns (3)-(4) of Table 1.3. Three alternative measures of spillovers are employed here. I use the benchmark spillover measure defined in (1.4) and two channel variables accounting for backward and forward linkages.

The construction of the channel variables for backward and forward link-
ages follows Javorcik [2004], as it has been adapted for the study of export spillovers by Choquette and Meinen [2014]. Since I do not have access to buyer-seller data, I use instead yearly input-output tables.

The channel variable for backward linkages accounts for information exchanges between firm $i$ operating in industry $s$ and importers of intermediate product variety $j$ operating in ‘buying’ i.e. ‘downstream’ industries.

$$\text{Backward Linkages}_{s(r)kt} = \sum_{s' \neq s} b_{s't} S_{i(r)s'kt}$$

where $b_{s't}$ is the share (with respect to the total manufacturing input) of sector's $s$ output that serves as an input to any other manufacturing sector $s \neq s'$. Respectively, the channel variable for forward linkages accounts for information exchanges between firm $i$ operating in industry $s$ and importers of intermediate product variety $j$ operating in ‘supplying’ i.e. ‘upstream’ industries.

$$\text{Forward Linkages}_{s(r)kt} = \sum_{s' \neq s} f_{s't} S_{i(s)s'kt}$$

where $f_{s't}$ is the share (with respect to the total manufacturing input) of sector $s'$ output that serves as an input to sector $s$. 38

The results reported in Columns (3) and (4) suggest that spillovers arising from buyer-seller relationships indeed do matter. Within the same region, only the spillover effect from a firm’s buyers (i.e., backward linkages) is significant. In Column (4), I study spillovers arising from buyer-seller relationships beyond the regional boundaries. 39 Buyer-seller relationships continue

---

38 I only consider the total manufacturing input, hence $b_{s't}$ and $f_{s't}$ represent respectively the manufacturing component of sector’s $s$ input to sector’s $s'$ production and the manufacturing component of other sectors’ input to sector’s $s$ production process.

39 The channel variables are indices and as a result the interpretation of their respective coefficients is not directly comparable to the coefficient of the intra-industry spillover that counts...
to be important. Both channel variables are significant, though forward linkages adjusted spillovers only at the 10% level. Import relevant information channelled via inter-industry linkages is primarily diffused through backward linkages.

In Column (5), I explore the relative importance of physical proximity and industrial ties. Results confirm that exchanges of import-relevant information by firms operating in the same industry (competitors) are facilitated by proximity. No clear pattern of spatial decay emerges regarding inter-industry linkages. This is likely to be reflecting that buyer seller relationships are not critically determined by distance. As noted by Choquette and Meinen [2014], geographic proximity may matter more for some channels than for others.

Firms operating within the same region and industry continue to have the greatest effect on firm-level sourcing decisions, consistent with a ‘Porter’ interpretation of spillovers.

1.4.3 Sender Capacity: Who carries information?

The benchmark spillover measure in Equation (1.4) treats the information held by all importers symmetrically, assigning them identical weights. The underlying assumption for this formulation is that incumbent importers of intermediate product variety $j$, regardless of their intrinsic characteristics, carry equally relevant information and influence the sourcing decisions of their neighbours in a symmetric way. In Table 1.4, I investigate the relationship between spillover effects and the characteristics of existing importers.
Porters aiming to unpack the nature of the informational transaction from the ‘sender’s perspective’.

Business relevant information often disseminates through casual and professional interactions between employees (e.g. lunch breaks at local cafes, networking in industry-level events, buyer-seller relationships) but also via the labour mobility channel (i.e. employees switching jobs and transferring the knowledge and experience acquired in their previous employment to the new firm).\textsuperscript{40} Ergo, larger importers are likely to have a greater impact on firm-level sourcing decisions.

In column (2) I explore this point. I estimate the baseline specification using an employment-weighted spillover measure, where each incumbent importer is weighted by its size (i.e., number of employees). This spillover measure counts the number of employees working for other same-variety importers in the region thus allowing for larger (in terms of employment) importers to exert greater influence on individual firms’ sourcing decisions.

Column (3), explores whether more productive firms weigh more on their neighbours’ sourcing decisions. The estimation employs instead a productivity-weighted spillover measure where each incumbent importer is weighted by its relative productivity.

In the last column, I explore whether imported volumes convey any additional information over and above the information arising from the mere presence of importers. If neighbours import larger volumes of a particular

\textsuperscript{40}See for example, Mion and Opromolla [2014] who use matched employer-employee data and show that previously acquired export experience of managers transfers to their new employer as they switch firms.
variety, it is more likely that this product has successfully been integrated in their production process, which is a signal for the product's quality and reliability. Firms importing small volumes may be seen as experimenting with a new intermediate product variety that may or may not become part of their production process. Thus, larger imported volumes may reduce the uncertainty surrounding the adoption of a new intermediate product variety. I therefore include the average volume of variety $j$ imported by (other) firms in the region and industry cluster among the controls in the preferred specification in (1.12).

The results reported in Table 1.4, provide support for continuing to use the number of importers as the preferred spillover measure. Once accounting

### Table 1.4: Who carries information (A)

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
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<th>(4)</th>
</tr>
</thead>
<tbody>
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<td>$Spill_{rsjt-1}$</td>
<td>0.0895***</td>
<td>0.0721***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(0.0048)</td>
<td>(0.0054)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># employees working for firms in ${r, s}$ importing $j$ ($t-1$)</td>
<td>0.0001*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(0.0000)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># firms in ${r, s}$ importing $j$, weighted by their relative productivity ($t-1$)</td>
<td>0.0000***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(0.0000)</td>
<td></td>
<td></td>
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<tr>
<td>average imported volume</td>
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<tr>
<td>(0.0000)</td>
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<td></td>
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<tr>
<td><strong>Full controls</strong></td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
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<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year FE$x$Product-Country FE</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year FE$\times$Region-Industry FE</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<td>536,655</td>
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<td>62,623</td>
<td>62,623</td>
<td>13,774</td>
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</tbody>
</table>

Notes: Fixed effects logit on the decision to start importing intermediate product variety $j$. Standard errors are reported in parentheses. *** $p$<0.01, ** $p$<0.05, * $p$<0.1. All right hand side variable are lagged (by one period). Non-binary variables are expressed in logarithms. Spillover variables are in levels.
for the number of same-variety importers in the region and industry, their size (in terms of employment), productivity and import scale do not matter.

In Table 1.5, I turn to the relationship between the organisational and ownership structure of incumbent importers, and the spillover mechanism.

Table 1.5: Who carries information (B)

<table>
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<th></th>
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<th>(6)</th>
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<td><strong>Spillover</strong> (t-1)</td>
<td>0.0895***</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.0048)</td>
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<tr>
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<tr>
<td>single-plant (t-1)</td>
<td>0.0896***</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>(0.0048)</td>
<td></td>
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<td></td>
<td></td>
</tr>
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<td>multi-plant (t-1)</td>
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<td>(0.3009)</td>
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<td><strong>Ownership Structure:</strong></td>
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<td>affiliated with B.G. (t-1)</td>
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<td>(0.0063)</td>
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<td></td>
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<td></td>
<td>(0.0009)</td>
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<td></td>
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<tr>
<td>foreign-owned B.G. (t-1)</td>
<td>0.0542***</td>
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<td>(0.0127)</td>
<td></td>
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</tr>
<tr>
<td>Swedish-owned B.G. (t-1)</td>
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<td></td>
<td>(0.0075)</td>
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<tr>
<td>stand alone private (t-1)</td>
<td>0.1019***</td>
<td></td>
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<tr>
<td></td>
<td>(0.0080)</td>
<td></td>
<td></td>
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<tr>
<td>state-owned firms (t-1)</td>
<td>0.0504</td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td>(0.0848)</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>Importance of Headquarters:</strong></td>
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<td></td>
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<tr>
<td>HQs (t-1)</td>
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<td></td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td>(0.0049)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>plants (t-1)</td>
<td>0.0676</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>(0.0486)</td>
<td></td>
<td></td>
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<td><strong>Export Status:</strong></td>
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<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>exporters (t-1)</td>
<td>0.0847***</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>(0.0057)</td>
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<tr>
<td>non-exporters (t-1)</td>
<td>0.1085***</td>
<td></td>
<td></td>
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<td></td>
<td>(0.0127)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Full controls</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Firm-Product-Country FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year FE x Product-Country FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year FE x Region-Industry FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td># Observations</td>
<td>536,655</td>
<td>536,655</td>
<td>536,655</td>
<td>536,655</td>
<td>536,655</td>
<td>536,655</td>
</tr>
<tr>
<td># triads (firm-product-country)</td>
<td>62,523</td>
<td>62,523</td>
<td>62,523</td>
<td>62,523</td>
<td>62,523</td>
<td>62,523</td>
</tr>
</tbody>
</table>

Notes: Fixed effects logit on the decision to start importing intermediate product variety \( j \). Standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All right hand side variable are lagged (by one period). Non-binary variables are expressed in logarithms. Spillover variables are in levels.

In Column (2), I distinguish between multi-plant and single-plant importers operating in the region-industry cluster \{ r, s \}. The spillover effect is primar-
ily driven by the latter. One additional single-plant firm in the region and industry cluster, importing intermediate product variety $j$, is associated with a 1% increase in the probability that any other firm in the region-industry cluster will take up importing $j$. The coefficient on multi-plant firms is negative and not significant. The negative sign, may reflect the increased competition that smaller firms face from multi-plant firms.

In Column (3), the spillover variable is broken down according to the ownership structure into importing firms that are affiliated with some business group (domestic or foreign) and stand alone firms. In Column (4), same-variety importers in the region-industry cluster that are affiliated with business groups are further decomposed according to the business group’s country of origin, whereas the group of stand-alone importers is split into state-owned and private firms.

Privately-owned Swedish firms that are not affiliated with business groups, are the main source of import spillovers, followed by Swedish business groups and foreign business groups. State-owned firms fail to enter significantly.

Interestingly, in their international sourcing decisions, firms are more influenced by importers of akin organisational and ownership structure. This finding suggests that import-related information that is generated within more complex business structures is not easily accessible.

In Column (5), I distinguish between spillover effects arising from headquarters and plants. Only the coefficient on headquarters is significant, suggesting that international sourcing decisions are primarily generated at the

---

41 I refer to firms that are controlled by the central government, the county or the municipality.
headquarter level. It could also imply that information stemming from head-
quartes is perceived as more credible by surrounding firms.

In the last column, the spillover variable is decomposed with respect to the
export status of incumbent importers. The coefficients on both groups are
highly significant (at the 1% level) and comparable in magnitude.

1.4.4 Heterogeneous effects: How do firms differ in the way they absorb
import relevant information?

So far the empirical analysis has treated the influence of spillovers on firms’
sourcing decisions as being independent of the characteristics of the firm
receiving the information. However, firms may differ with respect to their
‘absorptive capacity’, i.e., their ability to assimilate import-relevant informa-
tion that spills over from established importers.

In Table 1.6, I am looking for evidence of heterogeneity with respect to size
(in terms of employment) and productivity. In Column (2), I interact the
spillover variable with the firm’s size (in terms of employment). The inter-
action term \((Spill_{j,t-1} \times size_{i,r,t-1})\) fails to enter significantly suggesting
that agglomeration effects are broadly similar for firms of different employ-
ment classes.\(^{42}\) In Columns (3) and (4), I interact the spillover variable
with a binary variable that takes the value of one, if the firm’s size is above
the sample’s median employment (8 employees), and a binary variable indic-
ating whether the firm’s size is above the sample’s mean employment (28
employees) respectively. None of the interactive terms is significant.

\(^{42}\) This finding further alleviates concerns arising from my decision to exclude from the working
sample firms with zero employees.
Table 1.6: Absorptive capacity (A)
Do bigger, more productive firms benefit more from import spillovers?

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Spill_{ir,t-1}$</td>
<td>0.0895***</td>
<td>0.0787***</td>
<td>0.0868***</td>
<td>0.0888***</td>
<td>0.1196***</td>
<td>0.0918***</td>
<td>0.0905***</td>
</tr>
<tr>
<td></td>
<td>(0.0048)</td>
<td>(0.0079)</td>
<td>(0.0050)</td>
<td>(0.0049)</td>
<td>(0.0361)</td>
<td>(0.0050)</td>
<td>(0.0049)</td>
</tr>
<tr>
<td>$Spill_{ir,t-1} \times \text{size}_i$</td>
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<td>(0.0027)</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\text{size}<em>i(t</em>{rs})$</td>
<td>0.6911***</td>
<td>0.6929***</td>
<td>0.6942***</td>
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</tr>
<tr>
<td></td>
<td>(0.0155)</td>
<td>(0.0154)</td>
<td>(0.0154)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>$Spill_{ir,t-1} \times \text{above median size}$</td>
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</tr>
<tr>
<td>$Spill_{ir,t-1} \times \text{above mean size}$</td>
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<td>-0.0034</td>
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<td></td>
<td>(0.0160)</td>
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</tr>
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<td>$Spill_{ir,t-1} \times \text{productivity}$</td>
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<td></td>
<td>-0.0021</td>
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<td>(0.0025)</td>
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<tr>
<td>$Spill_{ir,t-1} \times \text{above median productivity}$</td>
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<td></td>
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<td></td>
<td>-0.0074*</td>
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<td></td>
<td>(0.0037)</td>
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</tr>
<tr>
<td>$Spill_{ir,t-1} \times \text{above mean productivity}$</td>
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<td>-0.0055</td>
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<td>(0.0045)</td>
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Full controls: Yes, Yes, Yes, Yes, Yes, Yes, Yes, Yes
Firm-Product-Country FE: Yes, Yes, Yes, Yes, Yes, Yes, Yes, Yes
Year FE: Yes, Yes, Yes, Yes, Yes, Yes, Yes, Yes
Year FE×Product-Country FE: Yes, Yes, Yes, Yes, Yes, Yes, Yes, Yes
Year FE×Region-Industry FE: Yes, Yes, Yes, Yes, Yes, Yes, Yes, Yes

# Observations: 536,655, 536,655, 536,655, 536,655, 536,655, 536,655, 536,655, 536,655

Notes: Fixed effects logit on the decision to start importing intermediate product variety $j$. Standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All right hand side variable are lagged (by one period). Non-binary variables are expressed in logarithms. Spillover variables are in levels. $\text{size}_i(t_{rs})$ refers to the log of the number of employees.
Columns (5)-(7) repeat the routine detailed in columns (2)-(4) but studying heterogeneity with respect to productivity. $Spill_{irjt} \times above_{\text{mean\_productivity}}$ is significant but only at the 10% level. The coefficient on the interaction term is negative. More productive firms appear to benefit less from spillovers. This may be because more productive firms can afford to incur the costs associated with gathering information. Across specifications the coefficient on the spillover variable remains unaffected by the inclusion of the interaction. The findings in Table 1.6, provide no clear evidence of heterogeneity with respect to the firm’s size or productivity levels.

Results presented in Table 1.7, provide no evidence that the influence of the spillover mechanism on firm-level sourcing decisions depends on other firm-specific characteristics such as, a firm’s export status (Column 2), a firm’s affiliation to a business group (Column 3), or the firm’s ownership structure (Column 4). None of the interaction terms is significant and their inclusion doesn’t affect the coefficient on the spillover variable.

### 1.5 Robustness Checks

The identification of spillovers is challenging from an econometric perspective. Lacking a truly exogenous variation in the data and in the absence of a reliable instrument, the empirical design is exposed to the identification concerns that are inherent to this literature. Nevertheless, I believe I come as close as possible to providing evidence on import spillovers. Results are robust to a range of sensitivity tests.
Chapter 1. Importers’ Clusters & the Sourcing Decisions of Swedish Firms

Table 1.7: Absorptive capacity (B)

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
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</tr>
</thead>
<tbody>
<tr>
<td>$\text{Spill}_{irsjt} - 1$</td>
<td>0.0895***</td>
<td>0.0914***</td>
<td>0.0868***</td>
<td>0.0896***</td>
</tr>
<tr>
<td></td>
<td>(0.0048)</td>
<td>(0.0052)</td>
<td>(0.0053)</td>
<td>(0.0048)</td>
</tr>
<tr>
<td>$\text{Spill}<em>{irsjt} - 1 \times \text{Exporter}</em>{i(rs)jt}$</td>
<td>-0.0044</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>(0.0048)</td>
<td></td>
<td></td>
</tr>
<tr>
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<td></td>
<td>0.1788</td>
<td>(0.0954)</td>
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<td>Yes</td>
</tr>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year FE</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year FE × Region-Industry FE</td>
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<td>Yes</td>
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</tr>
<tr>
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<td>536,655</td>
<td>536,655</td>
<td>536,655</td>
</tr>
</tbody>
</table>

Notes: Fixed effects logit on the decision to start importing intermediate product variety $j$. Standard errors are reported in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. All right hand side variable are lagged (by one period). Non-binary variables are expressed in logarithms. Spillover variables are in levels. ‘$\text{Spill}_{irsjt} - 1 \times \text{Exporter}_{i(rs)jt}$’ is the interaction term between the benchmark spillover variable and the country-specific export status of firm $i$, which takes the value of one, if $i$ is already present in market $c$ via exporting. ‘$\text{Spill}_{irsjt} - 1 \times \text{BG}_{i(rs)jt}$’ is the interaction term between the benchmark spillover variable and the binary variable $\text{BG}_{i(rs)jt}$, which takes the value of one if the firm is affiliated with a business group. ‘$\text{Spill}_{irsjt} - 1 \times \text{state-owned}_{i(rs)jt}$’ is the interaction term between the benchmark spillover variable and the binary variable $\text{state-owned}_{i(rs)jt}$, which takes the value of one if the firm is not private.
1.5.1 Spillovers or Common Shocks?

One potential concern is that the estimated positive and significant relationship between the probability that firm \( i \) operating in \( \{r, s\} \) starts to import any intermediate product variety \( j \) and the agglomeration of existing importers of \( j \) in \( \{r, s\} \), is driven by a response to unobserved shocks that impact firms’ sourcing decisions. The preferred specification includes year effects with and without a region-industry and a product-country dimension. What these effects will not correct for is endogeneity arising from the following types of shocks.

**Region- or industry-specific demand shocks:** If all firms in a given region \( r \) and industry \( s \), were hit by a shock impacting their production capacity and consequently their demand for specialised inputs, then all import starts associated with inputs used by the affected firms (irrespective of the source-market) would be also affected. The resulting bias in the estimation of spillovers could be corrected by controlling for such shocks through year effects with a product-region and product-industry dimension respectively. Import spillovers are then identified on the heterogeneity across destinations within a given product-industry-year, product-region-year or product-region-industry-year intersection. I therefore augment the baseline specification to account for such shocks by including year effects with a product-region (Year FE×Product-Region FE) and a product-industry (Year FE×Product-Industry FE) dimension in Columns (2) and (3) of Table 1.8.

**Shocks specific to a region and a source-market:** Events such as, the launch of a trade promotion office in a region, the acquisition of a local firm by a foreign business group, a local firm hiring a foreign manager etc.,
may impact the dynamics of bilateral trade relationships between that region and a given source-market and therefore the decision of firms located in that region to start sourcing intermediates from that market. I therefore include Year FE $\times$ Region-Country FE in Column (4) of Table 1.8 in order to address such concerns.

**Shocks specific to an industry and a source-market:** Consider the following scenario. A German firm, innovates by introducing an upgrade of an input $k$ that is intensively used in industry $s$. This will affect the decision of firms in the industry (regardless of their location) to start importing input $k$ from Germany. The effect on the firms’ propensity to start importing that variety would be confounded with the presence of spillovers. To address this, I include Year FE $\times$ Industry-Country FE in Column (5) of Table 1.8.

The findings are robust to all these exercises. The coefficient on the spillover variable remains highly significant and its magnitude is hardly affected.

The inclusion of year effects with different dimensions, though accounting for a variety of unobserved shocks cannot fully address the concern that what is being captured in the estimation process is the reaction to a shock affecting the propensity of firms in $\{r,s\}$ to import intermediate product variety $j = \{k,c\}$. If firms have different response times to such shocks the estimation is not in a position to account for this. Moreover, I am constrained from including Year FE $\times$ Product-Country-Region-Industry FE because these would be in the same dimension as the spillover variables.

Ideally, the spillover variable would be instrumented. The preferred instrumental variable, would be highly correlated with the instrumented variable.
(i.e., the spillover variable, \( \text{Spill}_{irsjt} \)), without directly affecting the variety-specific import decision. Unfortunately such an instrument proves difficult to identify in such a context as the literature on export spillovers would confirm.

Acknowledging this concern, the reader should also consider that in the presence of 15,576 distinct input varieties imported over 15 years by approximately 13,500 firms located in 80 employment areas results that survive a plethora of robustness checks are less likely to be driven by shocks so specific in nature. As a further exercise, following Greenaway and Kneller [2007], in Column (6), I break down the spillover variable according to when entry of peers in the import markets occurred, between contemporaneous and continuing importers. If the effects were primarily driven by contemporaneous importers, concerns that what we are actually capturing is likely to be the response to some common shock rather than agglomeration effects would be accentuated. As contemporaneous importers, I consider the firms that started to import the product-source market combination in question, at time \( t \) or \( t - 1 \),\(^{43}\) whereas continuing importers are the firms that started in \( t - 2 \) or earlier. Results further alleviate our concerns. The coefficients on ‘new’ (i.e., ‘contemporaneous’) and ‘old’ (i.e., ‘continuing’) importers are comparable in magnitude and highly significant. The effect coming from ‘older’ importers is stronger.

\(^{43}\)Since right hand side variables are lagged by a year that means that in fact ‘contemporaneous’ importers are firms that have been importing that particular product-source market combination for one or two years. Hence, continuing importers are the firms that have been importing that product source market combination for at least three years (or more).
**Table 1.8: Spillovers or response to common shocks?**

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<th></th>
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<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
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<td>( Spill_{it\neq t-1} )</td>
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<td>0.0887***</td>
<td>0.0885***</td>
<td>0.0890***</td>
<td>0.0898***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.0048)</td>
<td>(0.0048)</td>
<td>(0.0048)</td>
<td>(0.0048)</td>
<td>(0.0048)</td>
<td></td>
</tr>
<tr>
<td>new importers ((t - 1))</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>0.0771***</td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.0060)</td>
</tr>
<tr>
<td>old importers ((t - 1))</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
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</tr>
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<td>Yes</td>
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<td>Yes</td>
<td>Yes</td>
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<td>Yes</td>
</tr>
<tr>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year FE\times Product-Country FE</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<td>Year FE\times Region-Industry FE</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year FE\times Product-Region FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year FE\times Product-Industry FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year FE\times Region-Country FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year FE\times Industry-Country FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td># Observations</td>
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<td>536,655</td>
<td>536,655</td>
<td>536,655</td>
<td>536,655</td>
<td>536,655</td>
</tr>
<tr>
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<td>0.013</td>
<td>0.013</td>
<td>0.014</td>
<td>0.014</td>
<td>0.013</td>
</tr>
</tbody>
</table>

**Notes:** Fixed effects logit on the decision to start importing intermediate product variety \(j\). Standard errors are reported in parentheses. *** \( p<0.01\), ** \( p<0.05\), * \( p<0.1\). All right hand side variable are lagged (by one period). Non-binary variables are expressed in logarithms. Spillover variables are in levels. 'new importers \((t - 1)\)' refers to the number of firms in \( \{r,s\} \) that start importing intermediate product variety \(j\) at \(t-1\). 'old importers \((t - 1)\)' refers to the number of firms in \( \{r,s\} \) that have started importing \(j\) at \(t-2\) or earlier.
1.5.2 Accounting for firm’s past experience

The preferred specification focuses on the effect of spillovers on ‘switches’ in the individual firms’ product- and country-specific import history i.e. on import starts. A number of switches can be recorded over the observed time period as a firm may temporarily discontinue the use of an intermediate product variety. Another identification concern is that the observed increase in the probability of starting to import any intermediate product variety \( j \) reflects the firm’s own past experience, rather than spillover effects.

In Table 1.9, I study whether spillovers continue to be important for individual sourcing decisions once we account for a firm’s own past import experience. In Column (2), I include in the controls, a dummy variable indicating whether the firm has previously imported that same variety.\(^{44}\) A firm that has at some point in the past imported a variety and then dropped its use is approximately 50% less likely to start importing that same variety at any time \( t \) in the future. The negative sign on the variety-specific import experience can be understood as reflecting a negative, unsatisfactory past experience with a particular variety that renders its future use less likely. Alternatively it can be interpreted as indicating that the firm’s production process has changed in a way rendering the use of that variety irrelevant.

When accounting for the firm’s past experience, the spillover variable is no longer significant. In Column (3), I restrict the sample to firm-variety im-

\(^{44}\)To avoid any endogeneity concerns arising from the fact that this variable would be a linear combination of my dependent variable, I restrict each firm’s relevant import history so as to exclude the first ‘switch’. I therefore only focus on firms that appear in my data after the year 2000. What dictates this restriction is the fact that the firms’ variety-specific import histories extend prior to the first year in the data. Hence, I cannot be sure that the first switch in the firm’s observed import history maps to the first time it started to import a particular variety \( j \).
import histories extending up to the time that the first 'switch' occurs. Results suggest that the estimated effect in Column (1) is driven by 'first-time' importers. Spillovers are relevant when the firm has no prior own experience of sourcing a given product-source market pair.

In Column (4), I account for a firm's product-specific past experience by including a dummy variable that takes the value one if the firm in question has previously imported that 4-digit product code (from any source market). Having imported the same 4-digit product code from any source-market in the past, is associated with 2.7p.p. increase in the probability of starting to import any variety of that product. In Column (5), I look more closely at the importance of the product-specific import experience by accounting separately for the firm's previous import experience with respect to a given product-country pair as well as for the firm's past experience in importing the same 4-digit product code from a different source market. Both variables are highly significant at the 1% level. A firm's probability of starting to import any given product-country pair (i.e., a particular product variety) is 7.4 p.p. higher if the firm has in the past imported any different variety of that 4-digit product code. This can be interpreted in the following way: If intermediate $k$ is an essential input to firm $i$'s production, $i$ is likely to start importing $k$ from any source market at any given time $t$. A firm that has in the past imported $k$ from a particular source-market and has discontinued its use is less likely to re-import that product variety again in the future. At the same time it is more likely to import that product from a different source-market. When accounting for $i$'s product experience, the spillover variable is only significant at the 5% confidence level.
In Column (6), I account for a firm’s source-market specific past experience by including a dummy variable that takes the value one if the firm in question has previously imported any product from that source market. A firm that has in the past imported any 4-digit product code from a given source-market is associated with an increase of 5.7 in the probability to start importing any given product-code from that source market. In Column (7), I account both for the firm’s variety-specific import experience and the firm’s past experience of importing a different 4-digit product code from the same source market. A firm that has previously imported any different 4-digit product code from a given source market, is 7.6 p.p. more likely to start importing that particular product code from that market. Accounting for a firm’s source-market import experience lowers the magnitude of the coefficient on the spillover. The spillover variable is highly significant in both specifications.

I go on to explore different dimensions of firms’ import experience in Table 1.10. Column (2) reports the results of the estimation, when the number of other source-markets from which the firm imports the product in question, is included among the controls. This variable captures firm-level product-related experience as well as within-product category economies of scope across different source markets. Furthermore, I interact the spillover variable with the experience variable, to investigate whether spillover effects on firm-level sourcing decisions depend on the breadth of the firm’s product-related import experience. Importing a given product from one additional source market is associated with a 4% increase in the probability of starting to import that intermediate product from any other source market. The interaction term \((Spill_{irsjt-1} \times \# \text{ other source markets})\) is not significant.
Table 1.9: Accounting for firm’s own experience (A)

<table>
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<tr>
<th></th>
<th>baseline</th>
<th>variety-specific experience</th>
<th>product-specific experience</th>
<th>source-specific experience</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mean</td>
<td>mean</td>
<td>mean</td>
<td>mean</td>
</tr>
<tr>
<td>Spill_{wajt-1}</td>
<td>0.0895*** (0.0048)</td>
<td>0.0444 (0.0450)</td>
<td>0.0895*** (0.0048)</td>
<td>0.0629** (0.0222)</td>
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<td>Measures of firm’s past import experience</td>
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<td>variety-specific</td>
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<td>-2.6829*** (0.0958)</td>
<td></td>
</tr>
<tr>
<td>product-specific</td>
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<td>0.2612** (0.0650)</td>
<td></td>
<td></td>
</tr>
<tr>
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<td>0.6965*** (0.1200)</td>
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<tr>
<td>source-specific</td>
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<td></td>
<td>0.5381*** (0.0382)</td>
<td></td>
</tr>
<tr>
<td>source (other products)</td>
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<td></td>
<td></td>
<td>0.7178*** (0.0424)</td>
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<tr>
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<td>Yes</td>
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<tr>
<td>Firm-Product-Country FE</td>
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<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Year FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year FE×Product-Country FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Year FE×Region-Industry FE</td>
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<td>536,655</td>
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<td>62,623</td>
<td>2,573</td>
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<td>0.324</td>
<td>0.013</td>
<td>0.033</td>
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Notes: Fixed effects logit on the decision to start importing intermediate product variety j. Standard errors reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All right-hand side variables are lagged (by one period). Non-binary variables are expressed in logarithms. Spillover variables are in levels. ‘variety – specific’ is a binary variable indicating whether the firm has previously imported intermediate input variety j; ‘product – specific’ is a binary variable indicating whether the firm has previously imported the same product (from any country); ‘product(other sources)’ is a binary variable indicating whether the firm has previously imported that input from a different source market; ‘source – specific’ is a binary variable indicating whether the firm has previously imported any input from a given source market and; ‘source(otherproducts)’ is a binary variable indicating whether the firm has previously imported a different product from the same market.
In Column (3), I include in the controls the number of other products firm $i$ imports from a given source market, to capture origin-specific experience or economies of scope across products. Importing one additional intermediate product from any given source market is associated with a 1% increase in the probability to start importing any other product code from that market. The interaction term $(Spill_{irsjt-1} \times \# \text{other products})$ fails to enter significantly suggesting that there is no heterogeneity of spillover effects for firms with broader source-market related import experience.

In Column (4), I am taking into account the diversity of import experience in the cluster by including in the controls a variable that counts the number of distinct varieties imported by all other firms in the region and industry. This variable although highly significant hardly matters for the individual import decisions as the coefficient’s order of magnitude is very small. The negative sign of the coefficient could be reflecting regional crowding out effects. I observe that the inclusion of measures of firm’s experience hardly affects the magnitude or significance of the baseline spillover variable.

1.5.3 Robustness to different specifications and different subsamples

In this section I investigate whether my findings are contingent on the choice of preferred specification, in other words, whether my findings are robust to using different subsamples and specifications. In Table 1.11, the first column repeats the benchmark specification. The second column estimates Equation (1.7) using the product-and-country specific import status instead of the ‘switch’ variable in the LHS. This specification captures the relationship between changes in the spillover variable over time (with respect to the
Chapter 1. Importers’ Clusters & the Sourcing Decisions of Swedish Firms

Table 1.10: Accounting for firms’ experience (B)

<table>
<thead>
<tr>
<th></th>
<th>baseline</th>
<th>scope of product-specific experience</th>
<th>scope of source-specific experience</th>
<th>scope of region-wide experience</th>
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<td>Spill_{i,j,t-1}</td>
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<td>0.0895***</td>
<td>0.0819***</td>
<td>0.0890***</td>
</tr>
<tr>
<td></td>
<td>(0.0048)</td>
<td>(0.0049)</td>
<td>(0.0052)</td>
<td>(0.0048)</td>
</tr>
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<td></td>
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</tr>
<tr>
<td></td>
<td>(0.0033)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spill_{i,j,t-1} × # other products</td>
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<td>536,655</td>
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<td>0.013</td>
</tr>
</tbody>
</table>

Notes: Fixed effects logit on the decision to start importing intermediate product variety \( j \). Standard errors clustered for region and industry and reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All right hand side variables are lagged (by one period). Non-binary variables are expressed in logarithms. Spillover variables are in levels. ‘# other source markets’ refers to the number of (other) source-market a product is being sourced from. Similarly, ‘# other products’ refers to the number of other products that the firm sources from that market. ‘# intermediate varieties imported by firms in \( \{r,s\} \)’ is the number of distinct product and country pairs that firms in \( \{r,s\} \) sort.
average level of importers' agglomeration over the entire period) and the firm's variety-specific import status rather than the firm's decision to start importing a given variety. Results survive the alternative specification and the coefficient on the benchmark spillover variable is highly significant and of a broadly similar magnitude.\footnote{Under this specification, to distinguish between firms that now incur the fixed entry cost associated with importing and firms that have already incurred it I also control for the lagged import status. Including the lagged import status poses serial correlation concerns that are taken into account in the estimation routine.}

In the third column, I restrict the working sample to firms whose full import history can be observed. These would be firms that first appear in my data after year 2000. Results are robust to this exercise as well but the coefficient on the spillover variable is lower. An additional importer in the region and industry is then associated with a 0.6% increase in the probability that firm $i$ will start importing a given intermediate product variety.

Column (4), repeats the baseline specification restricting attention to each firm's most important inputs, i.e., inputs for which the firm's input-specific import share is above the median share for the firm. Column (5) in turn, restricts attention to each firm's most important trade partners i.e. source markets for which the firm's share of purchases of intermediate inputs relative to total firm-level imports of intermediates is above the median share. These sample restrictions hardly affect the coefficients or the significance of the spillover variables. In Column (6), I enlarge the sample to include the import histories of both single-plant and multi-plant firms. For the latter group, the spillover variable is constructed at the HQ's neighbourhood. The coefficient on spillovers remains highly significant but is lower.
In Column (7), the baseline specification is used but the estimation now relies on a fixed effects linear probability model.\textsuperscript{46} The spillover coefficient remains highly significant in this specification as well, and the implied increase in the probability to start importing a given intermediate product variety is also close to 1%.

In Column (8), I examine how strict is the product-specificity dimension of the spillover effect. I include in the baseline specification, along with the number of same product and source market importers, the number of firms that import a different (4-digit) product code which falls in the same (broader) 2-digit product category. The latter term is not significant.

Last, Column (9) restricts the sample to durable starts only, i.e., variety-specific switches that lead to import links persisting for at least three consecutive periods. The coefficient remains highly significant though smaller in magnitude. One additional importer of a given variety in the region and industry is associated with 0.65% increase in the probability that firm \( i \) will start importing that variety at any time \( t \). Results allow me to conclude that the findings presented so far are not driven by occasional imports, which are in turn more prone to be the result of reactions to common shocks, a crucial endogeneity threat discussed in the previous section.

\textsuperscript{46}Results presented in Tables 3.1-1.10 are qualitatively not affected when a fixed effects LPM is used instead of the fixed effects logit.
Table 1.11: Different specifications and subsamples

<table>
<thead>
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<th>Specification</th>
<th>0</th>
<th>0.01</th>
<th>0.05</th>
<th>0.1</th>
<th>0.5</th>
<th>1.0</th>
<th>2.5</th>
<th>5.0</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full controls</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Firm-Product-Country FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year FE × Product-Country FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year FE × Region-Industry FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Adjusted R-squared</td>
<td>0.013</td>
<td>0.026</td>
<td>0.029</td>
<td>0.013</td>
<td>0.013</td>
<td>0.011</td>
<td>0.013</td>
<td>0.104</td>
<td></td>
</tr>
</tbody>
</table>

Notes: Fixed effects logit on the decision to start importing intermediate product variety \( j \). Standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All right hand side variables are lagged (by one period). Non-binary variables are expressed in logarithms. Spillover variables are in levels.
1.6 Additional Results

1.6.1 Spillovers and the intensive margin of global sourcing

As discussed in Section 1.2, the modelling assumption regarding import spillovers is that they operate via lowering the informational component of the fixed costs associated with entry into international markets of intermediates.

In Chaney [2008] a change in the fixed costs of exporting only impacts the extensive margin, i.e., the equilibrium number of exporters, whereas changes in variable trade costs affect both the intensive and the extensive margins. Theoretical predictions of models of international sourcing do not sustain this dichotomy between the effects of fixed and variable trade costs on the trade margins. Antràs et al. [2017] show that a firm’s extensive margin of sourcing weakly increases with reductions in both fixed and variable trade costs. Chapter 2 of this thesis (Pateli [2018]), using an Armington-style theoretical framework to model firms’ sourcing decisions replicates this prediction and further finds that a spillover mechanism operating via lowering the fixed sourcing costs affects both margins.

To assess the effect of spillovers on the intensive margin I estimate the fol-
lowing equation:  

\[
demand_{i(r)s}^{jt} = \gamma_0 + \gamma_1 \text{price}_{i(r)s}^{jt-1} + \gamma_2 \text{Productivity}_{i(r)s}^{t-1} + \\
\gamma_3 \text{InputCosts}_{i(r)s}^{t-1} + \gamma_4 \text{Demand}_{rjs}^{t-1} + \gamma_5 \text{GDP}_{ct}^{t-1} + \\
\gamma_6 \text{Imports}_{ct}^{t-1} + \gamma_7 \text{Spill}_{irsjt}^{t-1} + \delta_t + \delta_{ij} + t + \\
t \times \delta_j + t \times \delta_{rs} + \epsilon_{i(r)s}^{jt} 
\]  

\(1.12\)

\(\text{demand}_{i(r)s}^{jt}\) is the log of the imported volume (expressed in tons) of intermediate product variety \(j\) by firm \(i\) at time \(t\).  

\(\text{price}_{i(r)s}^{jt-1}\) is the firm-specific price of intermediate product variety \(j\), that is also proxying for the variety’s quality from the perspective of firm \(i\).  

\(\text{InputCosts}_{i(r)s}^{t-1}\) is the firm’s total input costs and \(\text{Demand}_{rjs}^{t-1}\) is the vector of region and industry characteristics (1.6). I account for the trade partner’s GDP and for Sweden’s total intermediate input purchase from that country.  

\(\text{Spill}_{irsjt}^{t-1}\), is the variable of interest. Subject to the endogeneity concerns discussed in the previous sections, the coefficient on spillovers \((\gamma_7)\), captures the effect of the agglomeration of importers operating in the same region and industry on the sourcing behaviour of firm \(i\) with respect to the imported volume of variety \(j\).  

\(\epsilon_{i(r)s}^{jt}\) is the unobserved error term. I augment (1.12) for firm-

---

47 As the estimated results are conditional on the fact that firm \(i\) in \(\{r, s\}\) imports variety \(j\), ideally, (1.7) and (1.12) would be estimated within an integrated Heckman selection model rather than sequentially as a two-part model. However, as similar factors affect both the decision to start importing variety \(j\) as well as demand for variety \(j\) and hence, similar independent variables are used in both equations there is no valid excluded variable for the selection equation. The Heckman sample selection model originally combines a first-stage probit (selection equation) and a second stage OLS regression (output equation). The literature has extended the Heckman model to panel data. Note however that the first stage probit coefficient is inconsistent in the presence of fixed effects. There is no conditional fixed effects probit as there is no sufficient statistic allowing fixed effects to be conditioned out of the likelihood and, including unconditional fixed effects manually yields biased estimators. The literature proposes some ways around this. More flexible sample selection models have been developed using logit in the first stage and t-student in the second. To the best of my knowledge however there is no consensus that these models are appropriate.

48 I am using the volume instead of the value to overcome firm-level quality sorting and pricing issues.
product-country fixed effects ($\delta_{ij}$), year effects ($t$) and year effects with a product-country ($t \times \delta_j$) and a region-industry ($t \times \delta_{rs}$) dimension.

<table>
<thead>
<tr>
<th>Table 1.12: Spillovers on the imported volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
</tr>
<tr>
<td><strong>Spill</strong>&lt;sub&gt;irsjt−1&lt;/sub&gt;</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Firm controls</td>
</tr>
<tr>
<td>Region-industry controls</td>
</tr>
<tr>
<td>Variety-controls</td>
</tr>
<tr>
<td>Source-market controls</td>
</tr>
<tr>
<td>Firm-Product-Country FE</td>
</tr>
<tr>
<td>Year FE</td>
</tr>
<tr>
<td>Year FE×Product-Country FE</td>
</tr>
<tr>
<td>Year FE×Region-Industry FE</td>
</tr>
<tr>
<td># Observations</td>
</tr>
<tr>
<td># triads (firm-product-country)</td>
</tr>
</tbody>
</table>

Notes: Fixed effects OLS on the imported volume (tons) of intermediate product variety $j$ (in logs). Standard errors clustered for region and industry and reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All right hand side variable are lagged (by one period). Non-binary variables are expressed in logarithms. Spillover variables are in levels.

I estimate (1.12) with OLS. Table 1.12, presents the results of the baseline estimation (in parallel to Table 3.1). I gradually add the relevant controls, ending with the preferred specification in Column (5).

We can only reject the null hypothesis (i.e., that $Spill_{irsjt}$ has no effect on the imported volume) at relatively low levels of statistical significance, potentially because we lack sufficient precision in the estimation. Results therefore provide no clear evidence of spillover effects on the imported volume.
1.7 Concluding remarks

In this chapter, I investigate the relevance and explore the nature of import spillovers on the firms’ decision to start importing, using an exceptionally detailed data set on Swedish firms’ imports, at the product-level and by source-country, spanning the period between 1997 and 2011. This is one of the first empirical studies providing evidence of spillover effects on the firms’ sourcing decisions. In addition, I further contribute to the understanding of firm-level import behaviour. My findings suggest that:

a. The number of same-variety importers in the firm’s neighbourhood and industry, is associated with a higher probability of starting to import that same intermediate product variety.

b. The spillover mechanism appears to be the strongest when specific to the intermediate product variety being sourced, suggesting that the informational component of fixed sourcing costs primarily consists of information attached to the characteristics of the particular product and source-market combination.

c. Inter-industry linkages and in particular, buyer-seller relations are an important channel for the transmission of import relevant information. Hence, spillovers are not confined within the boundaries of the region-industry cluster where the firm operates.

d. Import relevant information channelled via inter-industry linkages is primarily diffused through backward linkages representing ties between a firm and its buyers.
e. I find evidence that intra-industry spillovers are reinforced by physical proximity suggesting that learning from competitors’, international activities (importing in particular) is facilitated when they are geographically close and hence directly observable.

f. Import decisions are facilitated by the presence of importers that are comparable in terms of their organisational and ownership structure to the firm facing the sourcing decision.

g. Spillovers primarily affect the extensive margin of global sourcing, i.e., the firm’s international sourcing decisions. I find no strong evidence that spillovers affect the imported volume i.e. the intensive margin of sourcing.

My results are robust to accounting for firm and region characteristics believed to influence the import decision.
Acknowledgments

I am grateful to my supervisors Rikard Forslid and Anders Åkerman for their guidance as well as to Gianmarco Ottaviano and Swati Dhingra for their time, assistance and suggestions. I would also like to thank Stelios Arvanitis, Esther-Ann Bøler, Peter Fredriksson, John Morrow, Frank Pisch and Vincenzo Scrutinio for their very useful comments, academic staff and PhD students at the Department of Economics at Stockholm University and the Globalisation Team at the Centre for Economic Performance at the London School of Economics as well as participants in the 2015 Nordic International Trade Seminar (NOITS), participants in the 15th GEP/CEPR Annual Postgraduate Conference and participants in the International Economics sessions of the 2016 Annual Conference of the Royal Economic Society for their feedback. I am of course responsible for any errors and omissions. I am also grateful to the Jan Wallanders & Tom Hedelius Stiftelse for the generous financial support in the absence of which the completion of this paper would not have been possible.
Appendix

A.1 Dealing with processing trade

When analysing firms' decisions to import intermediates from abroad, one potential problem is the presence of firms that engage in 'processing trade'. In exchange for a fee these firms import, further process and then re-export goods that remain the property of a third party throughout. Processing trade poses problems since the observed import behaviour of these firms is rather distinct relating to the firm's decision to place itself in a global value chain and as a result, may blur my results on spillovers. Processing trade is also a source of measurement error. Since the processing firm doesn't own, purchase or sell the underlying products for its own account, these flows don't appear in the firm's balance sheets. They do however appear in the trade data. As I focus on spillover effects on the extensive, rather than the intensive margin of sourcing, measurement error concerns are not really relevant.\footnote{According to Eurostat's definition the coverage of the manufacturing sector consists of units that process their own materials, subcontract a part of the processing of their own materials, own legal rights and concepts of the product but subcontract the whole processing, or carry out the aforementioned subcontracted processes. Assembly of the component parts (whether self-produced or purchased) of manufactured products is also considered manufacturing. Although a manufacturing firm can be a processing firm it has to own part of its inputs to be classified as a manufacturer.} I also drop from my sample firms that in a given year, both import and export a given product code (resellers).

A.2 Firms' ownership

I focus on the import decisions of Swedish-owned firms, on the grounds that the determinants of foreign firms' import behaviour may be materially dif-
ferent as these firms are likely to be more integrated with global markets through their parent firm. What is more, from a data perspective I wouldn’t be able to distinguish between imports and intra-group purchases from the parent or other affiliates based abroad. This is also true for Swedish international firms, i.e., Swedish firms that have presence abroad. Swedish-owned firms represent 97.1% of manufacturing firms.

A.3 Dealing with multi-plant firms

Import-export data are at the firm level, matching each transaction with the identification number of the importing firm without specifying the exact establishment to which imports are destined. In the analysis of local spillovers, the agglomeration variables measure the number of importing neighbours in the vicinity of the establishment facing the import decision, which is not known for multi-plant firms.

I choose to overcome this difficulty by restricting my empirical analysis to the sourcing decisions of single-plant firms. This choice is motivated by at least two reasons. To start with, given that Sweden is a small open economy, not surprisingly, the majority of firms are indeed single-plant firms. In fact, 95.2% of manufacturers are single-plant firms. The second reason is that the alternative of constructing the spillover variable in the neighbourhood of the headquarters relies on reasonable, albeit strong assumptions about how firms’ import decisions interact with the organisational structure.\textsuperscript{50} Assuming that the decision for any plant to start importing is taken at the headquarter level hence spillovers matter only in the headquarter’s neigh-

\textsuperscript{50} i.e. that all importing decisions are taken at the headquarter-level and that all imports end up in the headquarter.
bourhood, implies a top-down flow of import relevant information between the different units of the firm. The latter approach is considered though as part of the robustness tests.

The definition of the multi-plant firm merits some further clarifications. First, the distinction between multi-plant and single-plant firms is based on the notion of the ‘local kind-of-activity unit’. The term KAU (kind of activity unit or Verksamhetsenhet, VE) groups all the parts of an enterprise contributing to the performance of an activity at the 4-digit level of NACE and corresponds to one or more operational subdivisions of the enterprise. KAU are the minimum organisational levels for which information about the production value, intermediate consumption, manpower costs, operating surplus, employment and gross fixed capital formation (GFCF) are available. The term local KAU, refers to the part of the KAU that corresponds to a local unit. The Swedish term is ‘Lokal Verksamhetsenhet’ (LVE in abbreviation). The concept of the local KAU is not exactly that of the plant, which is better summarised by the variable ‘Arbetstallet’, i.e., worksite, although according to the S.C.B. for most firms these two different entities in fact coincide.

Moreover, note that in each location I consider units belonging to the same firm as one single entity. Hence, in the construction of the spillover variables, different plants or rather activity units of the same firm located in the same region are only counted once in the number of neighbours.

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51 Information is generated at the HQ and diffused to the subunits whereas we don’t allow for information generated at the level of a subunit to flow up and blend into decisions taken at the HQ level or affect other organisational units of the firm. Although these are definitely interesting aspects of the internal organisation of the firm, they are beyond the scope of the current study. I therefore prefer to remain agnostic about these questions and try to adopt as few assumptions as possible.
The process of building the dataset is summarised in Table A.1.

**Table A.1: Data building - operations**

<table>
<thead>
<tr>
<th></th>
<th>number</th>
<th>% manuf.</th>
</tr>
</thead>
<tbody>
<tr>
<td>unrestricted data</td>
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<td></td>
</tr>
<tr>
<td>manufacturing firms</td>
<td>118,823</td>
<td>100</td>
</tr>
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<td>data cleaning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>firms with gaps in their history</td>
<td>5,756</td>
<td>4.8</td>
</tr>
<tr>
<td>firms with zero employees</td>
<td>83,468</td>
<td>70</td>
</tr>
<tr>
<td>firms declaring negative output</td>
<td>1,314</td>
<td>1.1</td>
</tr>
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<td>firms that have changed sector</td>
<td>8,775</td>
<td>7.4</td>
</tr>
<tr>
<td>firms that have changed location</td>
<td>4,432</td>
<td>3.7</td>
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<td>sample restrictions</td>
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<tr>
<td>single-plant firms</td>
<td>113,167</td>
<td>95.2</td>
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<td>foreign firms</td>
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<tr>
<td>transaction restrictions</td>
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<tr>
<td>BEC 2 and BEC 4 product categories</td>
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<td>resellers</td>
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<tr>
<td>imports from unique suppliers</td>
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<tr>
<td>working dataset</td>
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<td>11.4</td>
</tr>
</tbody>
</table>

**A.4 Summary Statistics**

Table A.2 presents observations by year for the estimation sample. In particular, Column (1) records the firms that are present in the dataset each year (regardless of their import status); Column (2) counts the number of firm-product-country trade links per year; Column (3) reports the number of firm-product trade links per year and; Column (4) the number of firm-country trade links per year.

Tables A.3 and Tables A.5 list observations by region (labor area) and sector respectively. Table A.6 presents summary statistics for different definitions of the spillover variable.
Table A.2: Summary statistics - observations by year

<table>
<thead>
<tr>
<th>Year</th>
<th>firm-year</th>
<th>firm-product-country-year</th>
<th>firm-product-year</th>
<th>firm-country-year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998</td>
<td>10,070</td>
<td>413,811</td>
<td>181,261</td>
<td>89,614</td>
</tr>
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<td>1999</td>
<td>10,236</td>
<td>424,703</td>
<td>186,135</td>
<td>91,762</td>
</tr>
<tr>
<td>2000</td>
<td>10,402</td>
<td>431,773</td>
<td>189,439</td>
<td>93,361</td>
</tr>
<tr>
<td>2001</td>
<td>10,443</td>
<td>436,746</td>
<td>191,515</td>
<td>93,776</td>
</tr>
<tr>
<td>2002</td>
<td>10,403</td>
<td>436,415</td>
<td>190,687</td>
<td>93,432</td>
</tr>
<tr>
<td>2003</td>
<td>10,394</td>
<td>435,766</td>
<td>190,703</td>
<td>93,404</td>
</tr>
<tr>
<td>2004</td>
<td>10,440</td>
<td>431,413</td>
<td>189,596</td>
<td>92,973</td>
</tr>
<tr>
<td>2005</td>
<td>10,435</td>
<td>425,483</td>
<td>187,516</td>
<td>92,083</td>
</tr>
<tr>
<td>2006</td>
<td>10,405</td>
<td>415,972</td>
<td>184,456</td>
<td>90,376</td>
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<tr>
<td>2007</td>
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<td>408,046</td>
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<td>89,589</td>
</tr>
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<td>9,942</td>
<td>394,130</td>
<td>176,222</td>
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<tr>
<td>2010</td>
<td>9,783</td>
<td>382,399</td>
<td>170,689</td>
<td>82,423</td>
</tr>
<tr>
<td>2011</td>
<td>9,619</td>
<td>372,253</td>
<td>166,238</td>
<td>80,370</td>
</tr>
</tbody>
</table>

Notes: First column records firms present in the dataset each year (regardless of their import status); Column (2) features the number of firm-product-country trade links per year. Column (3) features the number of firm-product trade links per year; Column (4) the number of firm-country trade links per year.
Table A.3: Summary statistics - observations by region (Labour Area), 2011

<table>
<thead>
<tr>
<th>Labour Area</th>
<th>Firm firm-product-country</th>
<th>Firm-product-country</th>
<th>Firm-country</th>
</tr>
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<tr>
<td>1</td>
<td>1,795 110,196 41,711 16,398</td>
<td>1,396 506</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>49 3,194 4,413 1,928</td>
<td>1,214 514</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>177 13,489 6,568 2,361</td>
<td>1,447 678</td>
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<tr>
<td>4</td>
<td>292 22,139 5,845 2,734</td>
<td>858 385</td>
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</tr>
<tr>
<td>5</td>
<td>181 17,275 6,568 2,361</td>
<td>2,077 645</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>337 11,728 5,845 2,734</td>
<td>5,811 2,268</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>369 25,546 9,611 3,525</td>
<td>1,919 760</td>
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</tr>
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<td>8</td>
<td>133 6,758 2,844 1,198</td>
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<td>9</td>
<td>98 4,26 1,919 760</td>
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</tr>
<tr>
<td>10</td>
<td>47 2,766 1,214 514</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>62 3,35 1,447 678</td>
<td></td>
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<td>12</td>
<td>37 1,935 858 385</td>
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<tr>
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<tr>
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<td>28 956 523 172</td>
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<td>43</td>
<td>29 1,467 639 248</td>
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</tbody>
</table>

Notes: First column records firms present in the region, 2011) regardless of their import status); Column (2) features the number of firm-product-country trade links per region. Column (3) features the number of firm-product trade links per region; Column (3) the number of firm-country trade links per region.
Table A.4: Summary statistics - observations by region (Labour Area), 2011 (cont’d)

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<td>838</td>
<td>202</td>
</tr>
</tbody>
</table>

Notes: First column records firms present in the region, 2011) regardless of their import status); Column (2) features the number of firm-product-country trade links per region. Column (3) features the number of firm-product trade links per region; Column (4) the number of firm-country trade links per region. 
Table A.5: Summary statistics - observations by industry (NACE 2)

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<th>firm-product-country</th>
<th>firm-country</th>
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<td>17,049</td>
<td>7,560</td>
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</table>

Notes: First column records firms present in the industry, 2011 regardless of their import status; Column (2) features the number of firm-product-country trade links per industry. Column (3) features the number of firm-product trade links per industry; Column (4) the number of firm-country trade links per industry.
Table A.6: Summary statistics - spillover variables

<table>
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<th># Obs.</th>
<th>Mean</th>
<th>STD</th>
<th>Min</th>
<th>Max</th>
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<td>27.9</td>
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<td>258</td>
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</tbody>
</table>

Notes: Spill_{rskc} stands for the # of importers in \{r,s\} importing the same product-country pair \{k,c\}; Spill'_{rskc} stands for the # of importers in \{r,s\} importing the same product code \(k\) but from a different country \(c\); Spill'_{rksc} stands for the # of importers in \{r,s\} importing a different product code \(k'\) from the same country \(c\); Spill'_{rskc'} stands for the # of importers in \{r,s\} importing a different product code \(k'\) from a different country \(c'\); Spill_{r'skc} stands for the # of importers located in a different region \(r'\) and operating in the same industry \(s\) that import the same product-country pair \(k,c\); Spill_{r's'kc} stands for the # of importers located in the same region \(r\) but operating in a different industry \(s\) that import the same product-country pair \(k,c\); Spill_{r's'kc'} stands for the # of importers located in a different region \(r'\) and operating in a different industry \(s'\) that import the same product-country pair \(k,c\).
Information spillovers & the margins of global sourcing
2.1 Introduction

I propose a theoretical framework to analyse firm-level international sourcing decisions in an environment allowing for unintentional exchanges of import-relevant information between firms, a phenomenon that the literature has come to name spillovers. To the best of my knowledge, this is the first paper to provide a model formalising import spillovers and their implications for the firm’s import behaviour (along both the intensive and the extensive margins of sourcing) and consumer welfare. Moreover, it is one of a few papers to study firm-level international sourcing decisions through the lens of a framework accounting for the fact that in contrast to standard export models, where firm profits are additively separable across destination markets, international sourcing decisions feature interdependences and hence cannot be treated in isolation.

This paper relates to three distinct strands of the international trade literature. First, it draws on the large body of theoretical and empirical literature on fixed costs and self-selection into import and export markets. There is evidence that in order to engage in international activities (either exporting or importing) firms incur significant, upfront fixed costs, i.e. costs that do not vary with the volume traded. These costs are in addition to per-unit costs, such as transport costs and tariffs, and are often sunk.\footnote{The modelling of fixed costs goes back to Roberts et al. [1995], Roberts and Tybout [1997], Clerides et al. [1998], Bernard and Jensen [1999], Melitz [2003] and others. In all these papers, fixed export costs are introduced in order to explain the self selection of firms into the export markets.}

The existence of such costs (coupled with CES preferences) implies that it is only the most productive, best performing firms that can profitably over-
come this barrier and become exporters and/ or importers. Indeed, it is by now a well-established finding in the literature that international traders are ‘superior’ performers compared to firms with ‘purely domestic’ activities. They tend to be bigger, generate higher value added, pay higher wages, employ more capital per worker as well as more skilled workers and have higher productivity.

The bulk of research on fixed costs has focused on verifying their existence and quantifying their magnitude. However, it remains largely unclear what these costs actually entail. They are generally perceived as capturing ‘market access’ costs such as, advertising, distribution, information and conform-

2 Absent the fixed costs all firms would export/import.

3 Indicatively Mayer and Ottaviano (2007) using firm-level data covering seven European countries (Belgium, France, Germany, Hungary, Italy, Norway and the UK) analyse the characteristics of firms involved in international activities through exports or foreign direct investment and establish that such firms are ‘superstars’. Bernard et al. (2011) show that U.S. importers are more than twice as large and about 12% more productive than non-importers. They also establish that exporting is a relatively rare activity and that exporters are significantly larger (by approximately 97% in terms of employment and 108% in terms of shipments): more productive (by roughly 11% for value-added per worker and by 3% in terms of the TFP); pay higher wages (by around 6%) and are relatively more capital- and skill-intensive than non-exporters. Eurostat, analysing data from eight European countries (Austria, Denmark, Finland, Germany, Latvia, Norway, Portugal and Sweden) spanning the period 2008-2012 establishes that firms engaging in international trade account for 75% of total employment. This analysis also establishes that in most countries exporters have increased their productivity more than non-exporters. The OECD Trade by Enterprise Characteristics (TEC) data corroborate similar patterns. According to this dataset, only a small percentage of firms are engaged in international trade, typically below 10% in OECD countries whereas the bulk of international transactions (in value) is concentrated among firms with more than 250 employees. Kasahara and Lapham (2013), use Chilean data and find evidence suggesting that whether or not a firm is importing intermediates for use in production is also important for explaining differences in plant performance. They also find that firms which both import intermediates and export their output tend to be larger and more productive than firms that are active in either market, but not both.

4 The relationship between participation in international trade and productivity is in fact bi-directional. It is not only the most productive firms that are able to profitably incur the fixed costs associated with international trade but there is also evidence that access to international trade increases firm-productivity. Although there are some papers pointing to a learning mechanism for exporters, this finding has mainly been established for importers; e.g., Halpern et al. (2015), Goldberg-Koujianou et al. (2010), Boler et al. (2015).

5 Recently, there have been some attempts to open ‘the black box’ of fixed costs and identify some aspects of fixed export costs e.g., Smeets et al. (2010).
ing to foreign regulations. For the most part, fixed costs are treated as exoge-
nous\textsuperscript{6} in the literature and the implications of different micro-foundations
in models of firm heterogeneity remain under-explored.\textsuperscript{7}

A significant part of the costs associated with international trade can be
thought of as informational transaction costs.\textsuperscript{8} For exporters, such costs are
\textit{inter alia} related to learning about the foreign market’s structure and available
opportunities, acquiring information about the regulatory framework
around packaging, labelling and testing standards, reaching out to foreign
buyers and learning about their tastes as well as establishing distribution
channels.

The respective costs associated with international sourcing pertain to ac-
quiring information about the availability, prices and quality of foreign in-
termediates, their technical characteristics and compatibility with domestic
regulations but also with the the firm’s own production process; identify-
ing potential suppliers and verifying their credentials as well as familiarising
with a different business environment and the conditions of contract en-
forcement in a foreign country.

In an interview survey of Swedish companies undertaken by the Swedish
National Board of Trade,\textsuperscript{9} \textbf{10\%} of manufacturing firms engaging in interna-
tional trade stated that Sweden should prioritise the provision of import ad-

\textsuperscript{6} An exception being Arkolakis (2010), where the fixed costs of serving a market are a function
of the endogenous fraction of consumers that firms choose to serve.

\textsuperscript{7} See Melitz and Redding (2014).

\textsuperscript{8} Allen (2014), examines how information frictions affect trade. Using data on regional agricu-
tural trade in the Philippines, he shows that information frictions are quantitatively im-
portant.

\textsuperscript{9} Kommerskollegium (2011).
vice. Moreover, 16% of manufacturing firms engaging in international trade stated that they wanted it to be easier to gather information about different regulatory frameworks. Relatedly another 10% submitted that Sweden should prioritise information networks.

Moreover, the emergence and expansion of companies that charge their customers in exchange for professional services, specialised to international sourcing is suggestive of the existence and magnitude of such costs. These companies undertake on behalf of their customers the process of identifying suitable suppliers; verifying product quality; dealing with customs procedures and; assuring product compatibility with domestic regulations, on-time delivery, and competitive pricing.

This paper is also closely related to the agglomeration literature. Agglomerations arise when firms of the same industry locate close to each other to take advantage of scale economies. The driving forces of agglomerations are (i) the benefit of labour pooling, i.e. the access of firms to a variety of skilled specialised employees as well as the access of specialised employees to jobs; (ii) final producers' access to a range of industry-specific intermediates and respectively the access of intermediate inputs producers to buyers and; (iii) the ease of communication, information transfers and exchange of innovative ideas facilitated by the proximity between firms. This is also known as the Marshallian 'trinity of agglomeration economies'.

The idea that the proximity to firms involved in international trade could induce more firms to follow suit has extensively been explored with regard

10 Famous examples of clusters are Silicon Valley, the "neighbourhood" of many of the world's largest high-tech corporations and the automotive industry in Detroit.
to exporting activities. Aitken et al. [1997], conceptualised the spillover effect in this context as the net effect of market and non-market externalities (information spillovers/externalities, competition effects and cost-sharing) between firms at proximity.\textsuperscript{11} The early literature on export spillovers provides mixed evidence for the mechanism. More recently, Koenig [2009] and Koenig et al. [2010], using a detailed dataset on French individual export flows, at the product-level and by destination country find that export spillovers are sector- and destination-specific. Koenig et al. [2010] argue that in light of increasing support for the destination-specific nature of export spillovers it is unsurprising that previous studies using aggregated data (across destinations) have failed to provide strong unanimous support for this effect. Choquette and Meinen [2014], provide further insights by investigating the different channels through which the export spillover effects come to play (labour mobility, intra-industry linkages and inter-industry linkages). In the recent contributions to export spillovers the spillover mechanism is assumed to operate via lowering the fixed costs associated with exporting.

The literature on export spillovers is primarily empirical. A notable exception is Krautheim [2013], who develops a model of trade featuring heterogeneous firms and monopolistic competition where fixed export costs decrease with the presence of other exporters. On the intensive margin, Rauch and Watson [2003], show that the agglomeration of exporters mitigates the uncertainty that the buyer faces at the onset of a commercial relationship regarding the supplier’s ability to deliver larger orders, leading to larger ex-

\textsuperscript{11} The empirical literature on export spillovers has been developed among others by Greenaway and Kneller [2007], Karpaty and Kneller [2011], Andersson and Weiss [2012], Bernard et al. [2003], Barrios et al. [2003].
ports at the firm-level. Moreover, Cassey and Schmeiser [2013], develop a model based on Chaney [2008], where destination-specific export spillovers operate via the intensive margin on the back of a cost-sharing mechanism.

The import side of trade has so far received relatively less attention in the literature and this tendency carries over to the study of spillovers. Pateli [2016] is one of the first papers comprehensively investigating spillovers on firm-level import decisions. Using a rich data set on Swedish firms’ imports at the product-level and by source country, spanning the period between 1997 and 2011, the author provides evidence of spillovers on individual firms’ decisions to start importing a particular intermediate product from a given source market. The spillover mechanism is found to be the strongest when region- and industry-specific. The only other work I am aware of is Bisztray et al. [2017], who use firm-level data from Hungary and estimate knowledge spillovers between importers through spatial and managerial networks.

In the model I propose, import spillovers are perceived as exchanges of import-relevant information between existing and prospective importers of an intermediate product variety (i.e. product-country pair) and are assumed to occur within the boundaries of a region and industry cluster. I remain agnostic as to the incentives of the firms that engage on either side of this informational transaction and treat import spillovers as an externality.  

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12 See also Chapter 1 of this present thesis. An earlier paper by López and Yadav [2011], also explores spillover effects on imports of intermediate inputs. Having access to a less detailed data set, the authors are however restricted to a limited set of questions.

13 Unpublished paper.

14 Other papers explore this channel in depth. For example, Oberfield [2017] develops a theory in which the network structure of production forms endogenously. In this model, each entrepreneur sells a particular good and can employ a variety of techniques to produce that
therefore contribute to the literature with the first framework that formalises a spillover mechanism operating via lowering the fixed costs associated with international sourcing and explores its implications for the firms’ margins of global sourcing.

Finally, this paper also relates to the literature on firms' foreign sourcing decisions. Our knowledge about the determinants of firms' import behaviour remains incomplete. Bernard et al. [2011] provide comprehensive evidence that the main firm-level facts about exporters also hold for importers.\footnote{They show that importing is a rare activity and that U.S. importers are more than twice as large and about 12% more productive than non-importers.}

The study of the firm's decision to import intermediates however cannot be treated as the mirror image of the export decision. Import decisions feature \textit{interdependences} as international sourcing affects the firm's marginal cost of production. Hence, contrary to the general approach in the exporting literature, firms' entry decisions in the case of importing cannot be viewed in isolation. Moreover, the hierarchical sorting along the extensive margin that characterises export models does not arise as a general result in models of international sourcing.\footnote{In particular, in the presence of heterogeneous fixed costs (either country and/or product specific) the theory features no general predictions for the extensive margin of importing.}

Previously, several papers have developed theoretical frameworks that yield clear-cut general predictions for the extensive margins of importing by in-
flicting assumptions that mute these interdependences.\textsuperscript{17} These assumptions, are however at odds with the empirical patterns of global sourcing observed in the data.\textsuperscript{18} The challenges of modelling firm-level import decisions in the presence of such interdependences are explored in depth in a recent paper by Antràs et al. [2017].\textsuperscript{19} The authors build on the Eaton and Kortum [2002] framework and develop a model to analyse firm-level sourcing decisions in a multi-country world. In their setting, firms’ sourcing decisions consist of determining the set of markets that they will source their intermediate requirements from. They show that, under an empirically relevant condition, selection into importing exhibits complementarities across source markets and yields a pattern of strict hierarchical sorting, whereby less productive firms import intermediates from a subset of the source markets their more productive competitors source from. They exploit these complementarities to analytically define the extensive margin and go on to estimate the model applying an iterative algorithm developed by Jia [2008].

I use Antràs et al. [2017], as a reference and develop an Armington-style

\textsuperscript{17} See Goldberg-Koujianou et al. [2010], Kasahara and Lapham [2013], Gopinath and Neiman (2014), Halpern et al. [2015] et cetera.

\textsuperscript{18} These papers often assume that varieties within the same intermediate product class are perfect substitutes and/or that the fixed costs of sourcing are the same across intermediate products. Note however that in the data, firms source multiple varieties of the same intermediate product. Moreover, the patterns of global sourcing suggest that fixed costs associated with entry in the international markets of intermediates have both a source-market and a product dimension. See evidence illustrated in tables 2.1-2.4.

\textsuperscript{19} In addition, in an unpublished paper, Blaum et al. [2017a], build on a standard Armington-style framework of import behaviour and propose a general model featuring complementarities between sourcing decisions and fixed sourcing costs. Intermediates can be sourced domestically or from multiple countries, which exhibit quality differences (that is, foreign varieties can be of higher or lower quality). The model allows for unrestricted firm heterogeneity in firm-level productivity and fixed costs. They show that the theory features no general predictions for the extensive margin and go on to derive a robust and testable prediction for the intensive margin. Their main contribution is establishing a lack of homotheticity in international sourcing. Conditional on the extensive margin, larger firms spend more on their most important variety.
framework that exhibits ‘love for variety’ to model import-behaviour. I build a multi-country model of international sourcing with heterogeneous firms where I incorporate a spillover mechanism. Within each country, economic activity is spread across multiple regions and industries. Manufacturers use domestically produced intermediate inputs and also source intermediates from abroad. International sourcing is subject to variable (iceberg type) as well as fixed costs. The modelling of the firm-level sourcing decisions, departs from the Antràs et al. [2017] framework with respect to several key modelling assumptions. Firms’ sourcing decisions here consist in determining the product-country combinations that firms will include as inputs to their production process (rather than the set of source markets). Intermediate goods are differentiated by their country of origin, i.e. each intermediate product is produced in several countries around the world but, these product varieties are not seen as perfect substitutes from the final goods producers’ perspective. Therefore, the proposed framework allows for multiple active varieties per product and firms source the same product from multiple markets. Moreover, in the data we observe that only a handful of firms engage in international sourcing, importing a limited number of intermediate products from a few source markets. Consistent with this observation, I assume that fixed costs of sourcing have both a product and a source-market dimension unlike Antràs et al. [2017] where the fixed costs of sourcing are source-market specific.

My analysis focuses on the implications of import spillovers for the firms’ margins of global sourcing. I investigate how the characteristics of the spillover mechanism interfere with the determinants of firm-level import

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20 In fact, the proposed framework is akin to Blaum et al. [2017a].
behaviour and in particular, (a) the process of determining the set of intermediate product varieties to be used as inputs to the firms’ production (the firm’s extensive margin) and (b) firm-level import demand (the firm’s intensive margin). As in the reference paper, the presence of complementarities between the firms’ sourcing decisions delivers tractability, allowing me to characterise both the intensive and extensive margins of importing. Exploiting comparative statics and using the Topkis monotonicity theorem, I explore the interactions between the spillover mechanism and the margins of global sourcing.

I find that spillovers can enhance firms’ access to a wider range of intermediate product varieties. Given the growing evidence on the productivity gains accruing to importers of foreign intermediates,\textsuperscript{21} the import spillover mechanism appears to be another, not yet fully acknowledged, source of the productivity gains associated with agglomeration.

Moreover, so long as the spillover mechanism does not bias firms’ sourcing decisions towards intermediate varieties of inferior quality, accounting for informational exchanges between importers can expand the cost savings arising from inputs trade and result into lower consumer prices. However, to the extent that the spillover mechanism encourages the adoption of intermediate product varieties of inferior quality and/or compatibility attributes, it

\textsuperscript{21} For example, Goldberg-Koujianou et al. [2010], using detailed firm-level data from India find that trade liberalisation through facilitating access to previously unavailable inputs fostered product creation, accounting on average for 31% of the new products introduced by domestic firms; Halpern et al. [2015], investigate the effect of importing inputs on firm productivity and attribute one quarter of the growth experienced by Hungarian firms between 1993-2002 to imported inputs; Bøler et al. [2015], find that R&D and international sourcing are complementary activities. An implication of their work is that improved access to imported inputs promotes R & D investments and, ultimately, technological change. Moreover, Kasahara et al. [2016], using Indonesian data show that importing substantially increases the relative demand for educated workers within each occupation.
leads to inefficiencies in the determination of the extensive margin of sourcing. This is particularly relevant for policy makers. As opposed to gathering information related to exporting activities, public interventions are rare in the case of importing. Subsequently, informal informational transfers across firms may be an important channel for lowering the cost of entry into international markets for intermediates. My findings however suggest that spillovers need not be the best way of gaining access to import relevant information. This is an argument in favour of policies focused on facilitating firms to build their sourcing strategy on the basis of what suits best their production requirements by lowering informational barriers associated with importing.

In addition, my findings suggest that import spillovers when embedded in a framework that is rich enough to account for the interdependences in the firms' international sourcing decisions it yields theoretical predictions that are closer to the data compared to other models in the literature. In particular, the strict hierarchical order of the extensive margin of sourcing that the Antràs et al. [2017] model delivers is too strong a prediction. In fact, while the data confirms that more productive firms tend to source more varieties, we often observe that less productive firms source different product-country combinations. The authors promote the heterogeneity of fixed costs of sourcing as a possible explanation for the violation of the strict hierarchy pattern in the data. Their structural estimation results highlight the importance of heterogeneous fixed costs in matching the model to the data. In the framework I propose however, the inclusion of a region- and industry-
specific spillover mechanism breaks down the strict hierarchy prediction, which here only holds within the boundaries of a region-industry cluster.

The paper is organised as follows: Section 2.2, summarises some key facts about the patterns of international sourcing analysing a data set of firm-level imports by product and by source-market, spanning a 14-year period and covering the universe of Swedish firms; Section 2.3, lays out the structure of the economy; Section 2.4, analyses the firm’s problem; Section 3.3, solves for the general equilibrium; Section 2.6, examines the impact of spillovers on the extensive and intensive margins of sourcing; Section 2.7, further discusses the nature of the spillover mechanism and the implications of adopting different formulations and the last section concludes.

2.2 Facts about international sourcing

2.2.1 Importing activity is rare and highly concentrated in the source-market and the product space

Table 2.1 shows that the import activity of Swedish firms is highly concentrated geographically, in the product space but also at the firm level. The median country is only involved in two firm-product cells but the top 1% of Sweden’s source markets are present in 5,824 distinct firm-product cells. Half the imported product codes are only present in 15 firm-country cells but the most intensively sourced products are active in more than 538 firm-country combinations.

Import activity is also highly concentrated at the firm level with the median firm sourcing only one product-country combination per year and the top
1% of importers sourcing more than 50.\textsuperscript{23}

The last four rows of Table 2.1, indicate that there is also considerable heterogeneity in Swedish firms’ sourcing behaviour regarding all dimensions of the extensive margin. The median importer only sources one product code from a single source market. The top 1% of importers though source from as many as 17 distinct markets, 30 different product codes. We also observe significant heterogeneity and concentration along the variety margin. Around half of Swedish importers source each intermediate from a single source market. The top 1% of importers however, source as many as 7 varieties per product (i.e. the same product code from 7 different source markets). In the same vein, 75% of importers source at most 3 product codes per market while 1% source (more than) 8 products per market.

I rely on these patterns to motivate the assumption that fixed costs of sourcing have both a source-market and a product-level dimension. If fixed costs were country-specific, we would expect the following pattern to arise in the data. Having incurred the fixed costs associated with gaining access to a source-market, firms would seek to source a number of products from the same market to spread the respective fixed costs across a number of transactions. We would then observe in the data firms importing multiple products from each market for which they have incurred the fixed sourcing costs. On the contrary, if fixed costs were product-specific, firms would be observed sourcing multiple varieties of a few product codes. The lower panel of Table 2.1 instead shows that only a few firms engage in international sourcing and

\textsuperscript{23These results should not be viewed as a oddity of the Swedish data. They are in accordance with findings of Blaum et al. (2017a), for French firms and Gopinath and Neiman (2014) for Argentinian firms.}
that the majority of importers only source a small number of products from a handful of countries.\footnote{I discuss this assumption in more detail in Appendix E.}

<table>
<thead>
<tr>
<th>Percentiles</th>
<th>25%</th>
<th>50%</th>
<th>75%</th>
<th>90%</th>
<th>99%</th>
</tr>
</thead>
<tbody>
<tr>
<td># of annual trade interactions per source-market</td>
<td>1</td>
<td>2</td>
<td>42</td>
<td>472</td>
<td>5,824</td>
</tr>
<tr>
<td># of annual trade interactions per product</td>
<td>3</td>
<td>15</td>
<td>46</td>
<td>142</td>
<td>538</td>
</tr>
<tr>
<td># of annual trade interactions per firm</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>13</td>
<td>54</td>
</tr>
<tr>
<td># of source markets per firm</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>7</td>
<td>17</td>
</tr>
<tr>
<td># of products per firm</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>8</td>
<td>30</td>
</tr>
<tr>
<td># of products per source market</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td># of source markets per imported variety</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>7</td>
</tr>
</tbody>
</table>


### 2.2.2 Importers are different

Firms that are active in international markets (either through importing, exporting, or foreign direct investment) are known to systematically differ from firms with purely domestic activities. They tend to be bigger, employ more workers, pay higher wages and, feature higher productivity. Table 2.2 shows that Swedish firms that either import or export have on average almost double the production scale, employ circa 50\% more workers, pay around 5\% higher wages and are almost 20\% more productive compared to firms that neither export nor import. Moreover, firms that enter foreign markets both to source intermediate inputs and to sell their output significantly outperform firms with only domestic activities.
Essays on International Trade

Table 2.2: Firms with international activity differ

<table>
<thead>
<tr>
<th></th>
<th>firm neither imports nor exports</th>
<th>firm only exports</th>
<th>firm only imports</th>
<th>firm both imports and exports</th>
</tr>
</thead>
<tbody>
<tr>
<td>employment</td>
<td>8.5</td>
<td>13.7</td>
<td>12.3</td>
<td>40.6</td>
</tr>
<tr>
<td>wage (tsd. SEK)</td>
<td>251.8</td>
<td>263.5</td>
<td>266.9</td>
<td>289.5</td>
</tr>
<tr>
<td>VA per worker (mn SEK)</td>
<td>1.3</td>
<td>1.6</td>
<td>1.7</td>
<td>1.9</td>
</tr>
<tr>
<td>output (mn SEK)</td>
<td>11.2</td>
<td>20.6</td>
<td>20.3</td>
<td>83.2</td>
</tr>
</tbody>
</table>


2.2.3 Importers’ premia are increasing along the variety margin of sourcing

Differences in the performance of importing and non-importing firms increase with the intensity and the scope of import activity. Table 2.3, summarises the relationship between firm characteristics and the firm-level extensive margin of importing. Swedish data suggest that high performance firms tend to import a greater range of intermediates. In particular, firms that import more than ten distinct product-country combinations are almost 9 times bigger (in terms of output) and almost 6 times bigger in terms of employment, compared to firms that source a single intermediate variety from abroad. Table 2.4 communicates another interesting pattern that we observe in the data. High performance firms tend to source the same product code from multiple countries. Firms that import on average at least ten varieties of the same product code are more than three times bigger in terms of employment and almost six times bigger in terms of output compared to firms that source each product code from a single origin.
Table 2.3: The variety margin of importing (A)

<table>
<thead>
<tr>
<th>varieties (number)</th>
<th>Employees (tsd SEK)</th>
<th>avg. wage (mn SEK)</th>
<th>Value Added per worker (mn SEK)</th>
<th>output (mn SEK)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>12.5</td>
<td>265.5</td>
<td>1.5</td>
<td>18.5</td>
</tr>
<tr>
<td>2</td>
<td>15.0</td>
<td>271.5</td>
<td>1.8</td>
<td>24.0</td>
</tr>
<tr>
<td>3</td>
<td>17.7</td>
<td>277.3</td>
<td>1.8</td>
<td>29.2</td>
</tr>
<tr>
<td>4</td>
<td>18.7</td>
<td>281.9</td>
<td>1.9</td>
<td>31.2</td>
</tr>
<tr>
<td>5</td>
<td>22.4</td>
<td>286.8</td>
<td>2.0</td>
<td>40.0</td>
</tr>
<tr>
<td>&gt; 10</td>
<td>74.9</td>
<td>305.8</td>
<td>2.2</td>
<td>166.8</td>
</tr>
</tbody>
</table>

*Source: SCB, data on the universe of Swedish manufacturing firms (1997-2014); Notes: Firm-performance measures correspond to means over the period covered.*

2.2.4 Import activity is concentrated regionally

Figure 3.1, illustrates the regional patterns\(^{25}\) of import activity in Swedish data. Import activity appears to be spatially concentrated.

2.3 The Economy

There are \( C \) countries in the world. A given country \( c \in C \) consists of \( R \) distinct regions.\(^{26}\) Region \( r = 1, 2, \ldots, R \), is populated with \( L_r \) consumers, each endowed with one unit of labour inelastically supplied for production.

Within every region, economic activity is organised around three productive

\(^{25}\)Where region is the county.

\(^{26}\)Allowing for countries to feature a different number of regions doesn’t have material implications for the purposes of this exercise. I therefore do not index the set of regions with a country subscript. Moreover, allowing for multiple regions in the foreign countries is inconsequential for the results. The proposed framework is therefore equivalent to a framework where the foreign countries consist of a single region.
Regional concentration of import activity is measured by the number of importers in each county.
Table 2.4: The variety margin of importing (B)

<table>
<thead>
<tr>
<th>markets per product (number)</th>
<th>Employees (tsd. SEK)</th>
<th>avg. wage (mn. SEK)</th>
<th>Value Added per worker (mn. SEK)</th>
<th>output (mn. SEK)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>29.4</td>
<td>280.9</td>
<td>1.8</td>
<td>56.8</td>
</tr>
<tr>
<td>2</td>
<td>42.7</td>
<td>292.7</td>
<td>2.3</td>
<td>91.2</td>
</tr>
<tr>
<td>3</td>
<td>44.9</td>
<td>296.2</td>
<td>2.2</td>
<td>96.4</td>
</tr>
<tr>
<td>4</td>
<td>40.8</td>
<td>301.7</td>
<td>2.3</td>
<td>103.3</td>
</tr>
<tr>
<td>5</td>
<td>50.6</td>
<td>302.1</td>
<td>2.6</td>
<td>157.2</td>
</tr>
<tr>
<td>&gt; 10</td>
<td>110.3</td>
<td>357.7</td>
<td>3.1</td>
<td>330.5</td>
</tr>
</tbody>
</table>

Source: SCB, data on the universe of Swedish manufacturing firms (1997-2014); Notes: Firm performance measures correspond to means over the period covered.

functions: (i) the production of a homogeneous non-manufacturing good, (ii) the production of intermediate inputs and (iii) manufacturing production, which takes place in $S$ distinct industries.

2.3.1 Preferences

The representative consumer’s preferences are defined over the consumption of both the homogeneous non-manufacturing consumption good ($q_0r$), as well as the consumption of the composite output of each manufacturing industry $s \in S$. Her upper tier utility has a Cobb Douglas form:

$$U_r = q_0r \left(1 - \sum_{s=1}^{S} \eta_s \right) \prod_{s=1}^{S} (Q_{Mr_s})^{\eta_s}$$ (2.1)

The introduction of the numéraire good ($q_0r$) allows me to close the model while abstaining from the endogenous determination of wages, which is be-

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27 I assume that there are no differences in preferences between different regions.
yond the scope of this exercise. It is produced by perfectly competitive firms, using labour as the only input, subject to a country-specific technology requiring \( a^0_c \) units of labour to produce one unit of the numéraire. It is freely traded across regions within the country and also internationally. Provided that the commodity good is produced in all regions/countries,\(^{28}\) free trade leads to price equalisation across regions \( p^0_r = p^0_{r'} \). With perfect competition, the commodity’s price in each region is equal to the marginal production cost \( (w_r a^0_c = w_{r'} a^0_{c'}) \) leading to regional wage rates being equalised \( w_r = w_{r'} = w_c \), where \( w_c \) is the national wage rate. Moreover, free trade across countries leads to (international) price equalisation and pins down the relative country wage rates to the relative country-specific productivities in that sector \( p^0_c = p^0_{c'} \leftrightarrow w_c a^0_c = w_{c'} a^0_{c'} \leftrightarrow \frac{w_c}{w_{c'}} = \frac{a^0_c}{a^0_{c'}} \).

Preferences for the composite output of each manufacturing industry \( s \), are in turn defined over the consumption of horizontally differentiated varieties according to a standard symmetric CES aggregator.

\[
Q_{M_{rs}} = \left( \int_{\omega \in \Omega_{rs}} q_{rs}(\omega) \frac{\omega}{\sigma} \, d\omega \right)^{\frac{1}{\sigma-1}} \tag{2.2}
\]

\( \sigma > 1 \) is the elasticity of substitution between any two final good varieties. \( \Omega_{rs} \) is the set of horizontally differentiated manufacturing varieties that producers in industry \( s \) supply in equilibrium to consumers of region \( r \). Demand for each \( \omega \in \Omega_{rs} \) in region \( r \) is:

\[
q_{rs}(\omega) = \sigma\left(\frac{\sigma}{\sigma - 1}\right)^{\sigma - 1} B_{rs} p_{rs}(\omega)^{-\sigma} \tag{2.3}
\]

where \( p_{rs}(\omega) \) is the price consumers in region \( r \) pay for one unit of \( \omega \in \Omega_{rs} \),

\(^{28}\) Assume that the share \( 1 - \sum_{s=1}^{S} \eta_s \) of the external sector is large enough to ensure that this good will be produced in all regions and countries in an open economy equilibrium.
and $B_{rs}$ is defined as a region- and industry-specific market demand term:

$$B_{rs} \equiv \frac{1}{\alpha} \left( \frac{\sigma}{\alpha - 1} \right)^{\frac{1}{\alpha - 1}} \eta_s \nu L_r P_{M_{rs}}^{\alpha - 1}$$

The price local consumers pay for one unit of industry's $s$ composite output in region $r$ is:

$$P_{M_{rs}} = \left[ \int_{\omega \in \Omega_{rs}} p_{rs}(\omega)^{1-\sigma} d\omega \right]^{\frac{1}{1-\sigma}}$$

Consumer welfare in the region is a function of the overall price index $P^r$ and equal to

$$W^r = \frac{w}{P^r}$$

where

$$P^r = \left( 1 - \sum_{s=1}^{S} \eta_s \right)^{-\sum_{s}^{S} \eta_s} \left( \frac{1}{\sum_{s}^{S} \eta_s} \prod_{s=1}^{S} \eta_s^{-\eta_s} P_{M_{rs}}^{\eta_s} \right)$$

### 2.3.2 Production technology and market structure

Within each region-industry cluster $\{r, s\}$, there exists in equilibrium an endogenous measure of $N_{rs}$ producers operating under monopolistic competition.

The Melitz [2003] framework and timing apply. To enter industry $s$ in region $r$, firm $i$ faces a region- and industry-specific fixed cost of entry $f_{rs}^E$ (units of labour), that is thereafter considered sunk. After incurring the entry cost, firms [a] gain ownership of a ‘blueprint’ that entitles them to the production of a unique, horizontally differentiated variety of industry's $s$ composite output and; [b] gain access to a one-off draw from a (common) produc-

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29 The entry costs generate firm-level returns to scale and imply that each firm will choose to produce a unique variety $\omega$. 

tivity distribution.\footnote{\textsuperscript{30}} The core productivity parameter ($\phi$), is firm-specific, reflecting variation in ability across firms and is time-invariant.

I assume away both domestic (inter-regional) and international trade in final goods as the focus of the model is on the firms’ sourcing decisions. The simultaneous determination of the firm’s import and export decisions in the presence of spillovers between existing and prospective importers would introduce an additional layer of complexity that is beyond the scope of the question addressed here.

Manufacturing production requires each firm $i$ (located in region $r$ and operating in industry $s$)\footnote{\textsuperscript{31}} to determine its ‘sourcing strategy’ $\Gamma_i(\phi)$.

**Definition.** The firm’s sourcing strategy $\Gamma_i(\phi)$, describes the firm’s decisions regarding its extensive margins of sourcing, i.e. which intermediate products to include as inputs in its production process and where to source them from.

Intermediate goods are assumed to be differentiated by their country of origin and hence, inputs within the same product class produced in different countries are not treated as being perfectly substitutable from a manufacturer’s perspective.\footnote{\textsuperscript{32}}

The model therefore distinguishes between intermediate products and intermediate product varieties, where the latter term refers to an intermediate product variety produced in a specific country that has certain characteristics.

\footnotetext[30]{The productivity distribution is assumed to be common across regions, industries and countries.}

\footnotetext[31]{Each manufacturer is pinned down to a specific region and industry. Hence, there is no need to index firm-specific variables by region and/or industry. The subscript $i$ will stand for \textit{firm $i$ located in region $r$ and operating in industry $s$}.}

\footnotetext[32]{Depending on the country of origin differences may arise within the same product class with respect to quality, technology, compatibility with safety requirements and environmental standards (e.g. quality differences between Italian and Indian fabric; differences with respect to health and safety standards compliance between EU-produced and non-EU produced fabric dye et cetera.)}
product-country pair \( j = \{k, c\} \). \( k \in K^w \), where \( K^w \) is the global space of intermediate products and \( c \in C \), where \( C \) is the set of countries in the world.\(^{33}\)

Conditional on \( \Gamma_i(\phi) \), the firm assembles a composite bundle of intermediate product varieties (\( X_i \)).\(^{34}\)

Equation (2.8) below, summarises the firm’s production technology:\(^{35}\)

\[
y_i(\phi) = \phi X_i(\Gamma_i(\phi)) \quad (2.8)
\]

Since the focus of the paper is on the determinants of the composition of \( X_i \) and the effect of spillovers between importers on individual sourcing decisions, the other factors of production (labor and capital) have been muted. Hence, the firm-level core productivity \( \phi \), governs the mapping between the composite intermediate bundle and the production of final goods.

\( X_i \) is in turn defined as a symmetric CES aggregator over imperfectly substitutable intermediate varieties, with a constant and symmetric elasticity of substitution equal to \( \varrho > 1 \).

\[
X_i = \left( \sum_{j \in \Gamma_i(\phi)} (I_{ij} \nu_{ij} x_{ij})^{\varrho-1} \right)^{\frac{1}{\varrho-1}} \quad (2.9)
\]

\( I_{ij} = \{1, 0\} \) \( j=1 \) is an indicator variable taking the value of one if intermediate product variety \( j \) is included in \( X_i \). The term \( x_{ij} \) denotes firm \( i \)'s demand

\(^{33}\) Let \( K_c \) stand for the set of intermediates produced locally in the home country \( c \in C \). For the purposes of this exercise it is not of interest whether \( K^w \) and \( K_c \) coincide i.e. whether all intermediate inputs are produced in all countries, or whether the set of domestically produced intermediates is a subset of the global set of intermediates. I therefore drop the subscripts and will hence denote the set of intermediate goods that are available to manufacturers as \( K \).

\(^{34}\) Under the conditions that guarantee the general equilibrium solution the assembly of the composite bundle of intermediate inputs is determined by the firm’s initial productivity draw, its location and activity.

\(^{35}\) Note that, in the absence of a nested production function there is no effective distinction between products and varieties. Each product-country combination is treated as a distinct product in its own right.
for each intermediate variety $j \in \Gamma_i(\phi)$. We can think of $\nu_{sj}, (\nu_{sj} \geq 0)$ as parametrising industry-specific ‘quality’ attributes attached to a particular variety. In this context, ‘quality’ encompasses any value generating characteristics, but also the degree of compatibility of a given intermediate variety with the industry’s production requirements and technology.\(^{36}\)

Producers of intermediate goods operate in a perfectly competitive environment.\(^{37}\) Labour is the only input and the production process is governed by $a_j$; the unit labour requirement in country $c$ for the production of intermediate input $k$.

It is also useful to define $\xi_{sj}$, known in the literature as ‘pure price’.\(^{38}\)

$$\xi_{sj} \equiv \frac{p_j}{\nu_{sj}}$$

\(^{(2.10)}\)

$p_j = \tau_{cc'}w_c a_j$ is the price manufacturers in country $c$ pay for (imported) intermediate product variety $j$. Manufacturers are price-takers regarding intermediates. The inverse of $\xi_{sj}$ is a measure of the ‘quality flow per dollar spent’ on variety $j$, or ‘value for money’.

\(^{36}\) Consider for example the quality encompassed in Pakistani cotton fabric from the perspective of a bed linen manufacturer versus that of a cleaning rugs manufacturer.

\(^{37}\) The model could instead incorporate a monopolistically competitive intermediate sector with a fixed mass of firms. As the focus here is on the sourcing decisions of final goods producers in the presence of a spillover mechanism rather than the determinants of the set of intermediate inputs, I have chosen to simplify the framework by normalising the intermediate sector. Qualitatively the results of interest would not be affected.

\(^{38}\) I assume that the quality attributes and the resulting price adjusted quality parameters vary at the intermediate variety level and are not equalised across inputs as it is often assumed in the literature. Blaum et al. [2017a] (and an earlier version dating 2013), show that while equalising price adjusted qualities is a convenient assumption, facilitating the characterisation of the firm’s extensive margin, it is not in fact consistent with the data. In particular, they show that expenditure shares within firm-product cells across sourcing countries, far from being equalised, are highly concentrated on few suppliers.
2.3.2.1 Domestic and international sourcing:

Domestically produced intermediates are freely traded between a country’s different regions. Final goods producers in country $c$ can therefore access domestically produced intermediate inputs that are relevant for their production process (i.e. $v_{sj} > 0$) without incurring any additional variable or fixed sourcing costs (i.e. $\tau_{rr',} = 1$ for $r, r' \in c$ and $f_j = 0$ for $j = \{k, c\}$ where $c$ is the home country).39

Manufacturers can also access intermediate inputs that are produced abroad subject to incurring both iceberg type variable trade costs, $\tau_{cc',} > 1$ for $c \neq c'$, as well as fixed sourcing costs $f_j > 0$.

Variable trade costs are specific to the trade partners’ country pair and do not depend neither on the region where the intermediate producer is located, nor the region where the manufacturer purchasing the intermediate is located. Moreover, variable trade costs are not product-specific, i.e. any intermediate input shipped from country $c'$ to country $c$ is burdened with the same variable cost.40

2.3.2.2 The spillover mechanism

The spillover mechanism takes the form of a variety-specific fixed sourcing cost,41 that decreases with $N_{rsj}$, the number of importers of variety $j$ oper-

---

39 Since the unit labour requirement for the production of intermediates is governed by a national-level technology and given that wages are equalised across the regions, the price for domestically produced intermediates doesn’t vary across regions.

40 This assumption is not relevant for the results.

41 Consistent with the evidence presented in Table 2.1
ating in the region-industry cluster \( \{r, s\} \).\(^{42}\)

\[
f_j(N_{rsj}) = \tilde{f}_j \times \left[ \delta_{rsj} N_{rsj} \right]^{-\beta}
\]  

(2.11)

In other words, equation (2.11) implies that as more firms in the region-industry cluster \( \{r, s\} \) incur \( f_j \) and take up importing variety \( j \), its use by other firms operating in the same cluster will gradually pick up as the associated fixed costs will be lower for subsequent importers. The underlying hypothesis for this formulation is that any knowledge acquired by existing importers (i.e. firms that have already incurred the respective fixed sourcing costs) may spill over to other firms in \( \{r, s\} \).

Parameters \( \beta, \delta < 0 \) contain the pace at which the fixed costs decline, ensuring interior solutions exist. \( \beta \) is the elasticity of the fixed cost with regard to \( N_{rsj} \) and represents the strength of the spillover mechanism.\(^{43}\) \( \delta_{rsj} < 1 \) is a scaling parameter that can be interpreted as a decay factor, reflecting the fraction of information being lost when transferred between firms. It is treated as being variety-specific since the information attached to some varieties may be more (or less) straightforward to share, as a result of differences in technical complexity (e.g. inputs that require specific knowledge, skills and/or experience in order to be integrated in the firm’s production process), or differences in the degree of firm-specificity of such information due to product customisation (e.g. niche technological equipment versus standard mechanical components).

The regional dimension of the scaling parameter takes into account the fact

\(^{42}\)The modelling of import spillovers therefore resembles Krautheim, 2013. The analysis focuses on the variety-specific spillover since the firms’ sourcing decision in the model are taken at the variety level.

\(^{43}\)To guarantee the existence of an interior solution, I impose \( \beta < \frac{\sigma - 1}{\sigma} < 1 \).
that location may also affect the nature of the informational transaction, as some environments are more conducive to the dissemination of information/knowledge. For example, regions that regularly host commercial events, regions that are close to government agencies and foreign government representations, or regions that attract specialised workers etc., can be expected to feature a higher level and intensity of informational exchanges.

In the same vein, the industry-specificity of the scaling parameter acknowledges that informational exchanges may be easier in some industries compared to others. Factors like the degree of innovation, the frequency of intra-industry fairs, governmental support, the degree of employment turnover etc., affect the diffusion of information/knowledge.

The formulation adopted in (2.11), assumes that exchanges of import-relevant information between firms are variety-specific (i.e. import relevant information is attached to a given product-country pair and is not transferrable across products and/or sources) and only occur within the boundaries of the region-industry cluster (i.e. import-relevant information fully depreciates with physical and/or technical distance). Under these assumptions (i.e. for $\delta_{-rsj} = \delta_{rs-sj} = \delta_{rs-j} = 0$, where $-r$ stands for any region other than $r$, $-s$ stands for any industry other than $s$ and $-j$ stands for any variety other than $j$), a closed form solution for the model can be obtained. In Section 2.7, I discuss the nature of the spillover mechanism in greater detail and focus on the theoretical implications of adopting a more general formulation that accounts for informational exchanges occurring on the back of inter-industry linkages and/or inter-regional ties.
2.4  The firm’s problem

The assumption that firms take prices for both domestic and imported intermediates as given and the modelling of the production function as featuring constant returns to scale, introduce a separability between the intensive and the extensive margins of international sourcing.

The separability between the two margins allows us to approach the firm’s profit maximisation problem \(\text{given its sourcing strategy}\) and hence, to establish some results for the intensive margin without first having to solve for the firm’s extensive margin. This is particularly useful, as solving analytically for the extensive margin of sourcing is a challenging and computationally demanding process (see the discussion in Section 2.4.2).

2.4.1  Profit maximisation, \textit{conditional on} \(\Gamma_i(\phi)\)

The firm’s profit maximisation problem is summarised by:\textsuperscript{44}

\[
\max_{\nu(\phi, \Gamma_i(\phi))} \pi_i(\phi, \Gamma_i(\phi)) = p_i(\phi, \Gamma_i(\phi))q_i(\phi, \Gamma_i(\phi)) - C_i(\phi, \Gamma_i(\phi))q_i(\phi, \Gamma_i(\phi)) - w \sum_{j \in \Gamma_i(\phi)} f_j(\mathbb{N}_{rsj})
\]

(2.12)

where \(q_i(\phi, \Gamma_i(\phi))\) is residually determined in (2.3). \(C_i(\phi, \Gamma_i(\phi))\) stands for the marginal production cost given the firm’s core productivity parameter \(\phi\) and conditional on its sourcing strategy \(\Gamma_i(\phi)\). Solution to this problem gives rise to the firm’s profit maximising price.

\[
p_i(\phi, \Gamma_i(\phi)) = \frac{\sigma}{\sigma - 1} C_i(\phi, \Gamma_i(\phi))
\]

(2.13)

\textsuperscript{44}Note the change in notation: Firm-level performance measures are no longer indexed by the variety \(\omega\) but by its productivity and sourcing strategy.
As it is standard in this class of models, the price charged is a constant mark-up over the firm’s marginal cost. Replacing (2.13) and (2.3) in (2.12) the profit function reads:

$$\pi_i(\phi, \Gamma_i(\phi)) = B_{rs} \left[ C_i(\phi, \Gamma_i(\phi)) \right]^{1-\sigma} - w \sum_{j \in \Gamma_i(\phi)} f_j(N_{rsj})$$  \hspace{1cm} (2.14)

2.4.1.1 Optimal input demand

To satisfy demand for its output, firm \(i\) requires

$$X_i(\phi, \Gamma_i(\phi)) = \frac{y_i(\phi)}{\phi} = \frac{1}{\phi} (\sigma - 1) B_{rs} C_i(\phi, \Gamma_i(\phi))^{-\sigma}$$  \hspace{1cm} (2.15)

units of the composite bundle of intermediate varieties.\(45\) Each firm, taking demand for its output as given and being a price taker in markets for intermediates, determines its optimal demand for the intermediate product varieties in its sourcing strategy. The solution to the firm’s cost minimisation problem yields:

$$x_{sj}(\phi, \Gamma_i(\phi)) = (\sigma - 1) \xi_{sj}^{1-\rho} \mathcal{P}_i(\phi, \Gamma_i(\phi))^{\rho-\sigma} B_{rs} \phi^{\sigma-1} \frac{1}{p_j}$$  \hspace{1cm} (2.16)

where \(\mathcal{P}_i(\phi, \Gamma_i(\phi))\), is the cost firm \(i\) faces in assembling one unit of the composite intermediate bundle \(X_i(\phi, \Gamma_i(\phi))\).

$$\mathcal{P}_i(\phi, \Gamma_i(\phi)) = \left( \sum_{j \in \Gamma_i(\phi)} \xi_{sj}^{1-\rho} \right)^{\frac{1}{\rho}}$$  \hspace{1cm} (2.17)

\(45\)Replace for \(p_i(\phi, \Gamma_i(\phi))\) from equation (2.13) in equation (2.3) to obtain local demand for the firm’s output \(q_{ri}(\phi))\). Then set \(y_i(\phi) = q_{ri}(\phi)\) in equation (2.8) and solve for \(X_i(\phi, \Gamma_i(\phi))\).
Following the terminology adopted in this strand of the literature, it is useful to define two more terms. The firm’s ‘sourcing capacity’ $\Theta_i(\Gamma_i(\phi))$: 

$$
\Theta_i(\Gamma_i(\phi)) = \sum_{j \in \Gamma_i(\phi)} \xi_{x_j}^{1-\rho}
$$

(2.18)

where $\xi_{x_j}^{1-\rho}$ is defined as the variety’s ‘sourcing potential’.

$\Theta_i(\Gamma_i(\phi))$ increases both with the number and the price/quality attributes of the intermediate product varieties that the firm uses as inputs in its production process (i.e. both with the number and the characteristics of the elements in its sourcing strategy set). In particular, conditional on $\Gamma_{i-j}(\phi)$, sourcing an additional variety $j$ expands $i$’s sourcing capacity. Moreover, conditional on $\Gamma_{i-j}(\phi)$, including variety $j$ with sourcing potential $\xi_{x_j}^{1-\rho}$ will induce a greater increase in $i$’s sourcing capacity compared to the alternative of including an ‘inferior’ variety $j’$ (i.e. for $\xi_{x_j}^{1-\rho} \geq \xi_{x_j'}^{1-\rho}$ we have $\Theta_i(\phi, \Gamma_{ij}(\phi)) \geq \Theta_i(\phi, \Gamma_{ij'}(\phi))$).

This term therefore, summarises the scope and worth of the firm’s international sourcing activity.

### 2.4.1.2 Marginal cost

Conditional on its sourcing strategy $\Gamma_i(\phi)$, firm $i$’s marginal cost reads:

$$
C_i(\phi, \Gamma_i(\phi)) = \frac{1}{\rho} \mathcal{P}_i(\phi, \Gamma_i(\phi)) = \frac{1}{\rho} \left( \Theta_i(\Gamma_i(\phi)) \right)^{1-\rho}
$$

(2.19)

---

46 These terms are defined in the same way -given the different modelling assumptions- as in Antràs et al. [2017].

47 i.e. $\Delta \Theta_i(\phi, \Gamma_{ij}(\phi)) \geq 0$. 

The firm’s marginal cost and therefore the price it charges to its customers (2.13), is a function of its sourcing capacity \( \Theta_i(\phi, \Gamma_i(\phi)) \).

The firm’s sourcing capacity reflects the potential for cost savings achieved via international sourcing. The cost savings from the inclusion of intermediate product variety \( j \) in firm \( i \)’s sourcing strategy is equal to:

\[
\Delta C_i(\phi, \Gamma_i(\phi)) = \frac{1}{\phi} \Delta \Theta_{ij}(\phi, \Gamma_i(\phi)) (1 - \rho)(2.20)
\]

Hence, all factors affecting firm-level sourcing decisions have a direct bearing on the firm’s variable production costs, prices and consumer welfare.

In a number of firm-level import models (see Antràs et al. [2017], Gopinath and Neiman [2014], Halpern et al. [2015], Kasahara and Rodrigue [2008], Amiti et al. [2014], Goldberg-Koujianou et al. [2010]) inputs trade is shown to lower the unit cost of production. These findings are particularly important as the cost-saving implications of inputs trade extend to consumer welfare. Indeed, in a recent paper Blaum et al. [2017b], develop a methodology to measure how consumer prices are affected by inputs trade. Applying their methodology to French data the authors find that prices of manufacturing products would be 27% higher in the absence of inputs trade.

In addition, note that a firm’s marginal cost depends both directly and indirectly (via \( \Theta_i(\Gamma_i(\phi)) \)) on \( i \)’s core productivity \( \phi \). It can be shown that a firm’s sourcing capacity is non-decreasing in \( \phi \) (Proposition 1).

\[
\Theta_{ij}(\phi, \Gamma_{ij}(\phi)) < \Theta_{i-j}(\phi, \Gamma_{i-j}(\phi)) \iff \left( \Theta_{ij}(\phi, \Gamma_{ij}(\phi)) \right)^{1-\phi} < \left( \Theta_{i-j}(\phi, \Gamma_{i-j}(\phi)) \right)^{\frac{1}{1-\rho}} \iff \Delta C_i(\phi, \Gamma_i(\phi)) < 0.
\]

Cost savings can arise from a firm gaining access to a wider range of inputs, cheaper inputs and/or to inputs of superior quality enhancing the firm’s efficiency.

See proof in Appendix A. Note however that this does not imply that more productive firms
(2.19), shows that firms with a high productivity draw, face lower variable costs both because they are more efficient in transforming intermediate inputs into final products and because they achieve a higher sourcing capacity.

### 2.4.2 Characterising the firm’s optimal sourcing strategy

\[
\max_{I_{ij} \in \{0, 1\}, j = 1} \pi_i(\phi, I_i) = \phi^{\rho - 1} \left( \sum_{j \in J} I_{ij} \xi_{ij}^{\rho - 1} \right)^{\frac{1}{\rho - 1}} B_{rs} - w \sum_{j \in J} I_{ij} f_j (N_{rsj})
\]

where \( I_{ij} \) is an indicator variable that takes the value one when \( j \in \Gamma_i(\phi) \) and is equal to zero otherwise.

#### 2.4.2.1 Individual sourcing decisions

Firm \( i \) will include variety \( j \) in its sourcing strategy set \( \Gamma_i(\phi) \) if and only if the firm’s profits when \( j \in \Gamma_i(\phi) \) are no smaller compared to its profits when \( j \notin \Gamma_i(\phi) \) e.g. when:

\[
\pi_i(\phi, \Gamma_i(\phi)) \geq \pi_i(\phi, \Gamma_i(-j)(\phi)) \iff \phi^{\rho - 1} \left( \Theta_{ij}(\phi, \Gamma_i(\phi)) \right)^{\frac{1}{\rho - 1}} B_{rs} \geq w f_j (N_{rsj})
\]

The last expression under equation (2.22) illustrates how the firm compares the marginal gain from adding variety \( j \) in its sourcing strategy, against the incremental fixed cost associated with sourcing that additional variety. The firm will include \( j \) in its sourcing strategy set if and only if, the former at

source more varieties. This finding should therefore not be interpreted as establishing hierarchical sorting in firms’ sourcing decisions. Moreover, this result is only established within the same region-industry cluster but needs not hold across regions and/or industries, as the factors affecting individual sourcing decisions differ. It is therefore possible that a low productivity firm achieves in equilibrium a higher sourcing capacity than a higher productivity firm operating in a different region-industry cluster.
least outweighs the latter.

The marginal gain from including variety \( j \) in \( \Gamma_i(\phi) \) is the result of the additional revenue accruing to the firm as \( i \)'s sourcing capacity increases, driving down the firms' variable production costs and hence, the prices it charges to local consumers.

In the presence of import spillovers the fixed costs associated with sourcing variety \( j \) decrease with the mass of importers of variety \( j \) in the region-industry cluster. All else equal, the more widespread the use of a given variety, the more likely it is that the inequality in (2.22) holds and therefore, that any firm \( i \) in \( \{r,s\} \) will include variety \( j \) in its sourcing strategy. Consequently, the existence and strength of import spillovers directly affect the trade-off that firms face in their sourcing decisions.

So long as the production function features some 'love for variety', the marginal gain accruing to the firm from including an additional variety \( j \) in \( \Gamma_i(\phi) \), depends on its entire sourcing strategy (i.e. both the number and the quality attributes \( (\xi_{sj}) \) of the other elements in the set \( \Gamma_i(\phi) \)) and not just the attributes of that additional intermediate variety.\(^{51}\) As a result, the solution to the problem laid out in (2.21), is not straightforward. The implication is that unlike export participation decisions, sourcing decisions are interdependent and cannot in general be viewed in isolation. The nature of these interdependences is critically determined by the value of \( \frac{\sigma-1}{\rho-1} \). There are three distinct cases:

\(^{51}\) It should be noted that there is an isomorphism between the framework employed in Antràs et al., 2017, which builds on Eaton and Kortum (2002) and the more standard in the literature Armington-style models. This isomorphism implies that interdependences between sourcing decisions characterise both frameworks.
Complementarities between sourcing decisions: For $\frac{\sigma - 1}{\rho - 1} > 1$, the profit function $\pi_i(\phi)$ features increasing differences in $(I_{ij}, I_{ij}')$ for $j, j' \in 1, 2, ..., J$ and $j \neq j'$. This case is more likely to arise when demand for the final good is elastic (high $\sigma$) and the substitutability between input varieties is relatively low (low $\rho$). When demand is elastic, variable cost reductions following the expansion in $i$'s sourcing capacity, translate into material increases in firm revenue since demand is more responsive to changes in prices. Moreover, the less substitutability there is between intermediate varieties, the greater the expected cost reductions from including an additional variety in the set. The marginal gain of including an additional element in $\Gamma_i(\phi)$ is therefore increasing in the firm’s built up sourcing capacity.

Substitutability between sourcing decisions: For $\frac{\sigma - 1}{\rho - 1} < 1$, the profit function features decreasing differences in $(I_{ij}, I_{ij}')$ for $j, j' \in 1, 2, ..., J$ and $j \neq j'$. The marginal gain from incorporating an additional variety in the sourcing strategy set decreases with the firm’s built-up sourcing capacity.

Independent sourcing decisions: In the special case where $\frac{\sigma - 1}{\rho - 1} = 1$, sourcing decisions feature no interdependences and can therefore be viewed in isolation. The characterisation of the extensive margin of sourcing is then equivalent to the characterisation of the extensive margin of exporting.

2.4.2.2 Does international sourcing exhibit a pattern of hierarchical sorting?

The absence of a general hierarchical pattern whereby more productive firms would source more intermediate varieties compared to their less productive competitors, characterises all models of international sourcing for which in-
individual sourcing decisions cannot be viewed in isolation. This is in contrast to export models.

In theory, intermediate varieties could be ranked in terms of their attributes (i.e. their sourcing potential and associated fixed costs) in a way reflecting the trade-off that firms face in their sourcing decisions.\footnote{A variety’s position in the ranking would depend positively on its quality parameters and negatively on the fixed costs associated with sourcing the variety from abroad.} An intermediate product variety’s position in this hypothetical ranking would represent its ‘appeal’, relative to the other available intermediate product varieties, from the perspective of the firm.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{appeal.png}
\caption{Diagram showing the ranking of intermediate product varieties based on appeal.}
\end{figure}

There is a direct link between the intermediate product varieties that form i’s sourcing strategy and their respective ranking. In other words, if I_{\phi}(\phi) comprised of z elements, these would correspond to the z most appealing varieties for the firm.

This is illustrated in the diagram above, where hypothetical intermediate product varieties have been ordered in decreasing sourcing appeal. The shaded part of the axis corresponding to the interval \([1, z]\), represents firm i’s sourcing strategy \(I_{\phi}(\phi)\), which comprises of the z top-ranked varieties.

In the absence of fixed costs,\footnote{Or if fixed costs were flat across all intermediate varieties.} the variety-specific quality/price attributes would be the only factors determining the attractiveness of an intermediate variety and therefore, the most appealing varieties would be the ones with
the highest sourcing potential.\textsuperscript{54}

The existence of fixed sourcing costs, forces firms to compromise their quality requirements against affordability considerations; ergo varieties that are characterised by a high $\xi^{1-\rho}_{s,j}$ and are also associated with high fixed sourcing costs could be ranked below varieties with a lower sourcing potential but also associated with lower fixed costs. Here, I make no explicit assumptions about the relationship between an intermediate variety’s sourcing potential and the relevant fixed cost.

The term ‘appeal’ or ‘attractiveness’ should therefore be understood as signalling accessibility, rather than a variety of superior quality.

It can be seen in (2.19), that a firm’s marginal cost (and the price it charges to local consumers) depends on the the number as well as, the sourcing potential of the intermediates that the firm has included in its sourcing strategy. Fixed sourcing costs only matter for the firm’s unit cost via their impact on determining the firm’s sourcing strategy.\textsuperscript{55} All factors affecting the ranking of intermediate varieties, including spillovers have a direct bearing on the firm’s sourcing capacity and the prices consumers face.

Note that, a variety’s attractiveness and hence its respective position in the ranking, needs not be a universal characteristic. In particular, for $\frac{\sigma-1}{\rho-1} < 1$ a high productivity firm may find it profitable to incur a high fixed cost in order to source a high $\xi^{1-\rho}_{s,j}$ variety. This is because the inclusion of a high

\textsuperscript{54} In this case and given that $\xi_{s,j}$ is industry-specific, the ranking of the varieties would be the same for all the firms operating in the same industry but need not persist across industries.

\textsuperscript{55} Note that if fixed sourcing costs were incurred in terms of the composite intermediate input, rather than in terms of labour, the firm-level marginal costs would also be a function of the fixed sourcing costs. This would nuance the results described in the proposed framework.
sourcing potential variety in the firm’s sourcing strategy would materially increase \( \Theta_i(\phi, \Gamma_i(\phi)) \), hence the prospective marginal gain from sourcing additional varieties would be (significantly) smaller.\(^{56}\) On the contrary, for a low productivity firm, incurring a high fixed cost to gain access to a variety with high sourcing potential may not be profitable. Such a firm may be better-off sourcing more varieties, which albeit characterised by lower \( \xi_{sj}^{1-\rho} \) they also inflict lower fixed costs. In that case, a variety’s attractiveness (and its ranking with respect to other available varieties) may be different for high versus low productivity firms. Hierarchical sorting breaks down as high productivity firms may be sourcing in equilibrium a handful of high quality and high fixed sourcing cost varieties, whereas the less productive firms may be sourcing a number of inferior quality intermediates that feature however lower fixed sourcing costs.

For \( \frac{\sigma-1}{\rho-1} > 1 \), the determinants of a variety’s attractiveness would be the same for all the firms operating in the same region-industry cluster \( \{r, s\} \) regardless of their productivity. The respective ranking of varieties would then be identical for all the firms in \( \{r, s\} \).\(^{57}\) For \( \frac{\sigma-1}{\rho-1} > 1 \), the model yields a strict hierarchical pattern, whereby the sourcing strategy of less productive firms is a strict subset of the respective sourcing strategies of their more productive competitors (Proposition 2).\(^{58}\)

The diagram below, illustrates this.

\(^{56}\)This is due to the decreasing differences characterising the profit function in the case where \( \frac{\sigma-1}{\rho-1} < 1 \).

\(^{57}\)Note that this result needs not hold across region-industry clusters however.

\(^{58}\)See Appendix B for proof.
The strict hierarchical order of the extensive margin of sourcing though is too strong a prediction. In fact, while the data confirms that more productive firms tend to source more varieties,\textsuperscript{50} we often observe that less productive firms source fewer but different product-country combinations.

Unlike the Antràs et al. [2017] model though, which also sustains a pattern of strict hierarchical sorting in the case where sourcing decisions feature complementarities, in the framework I propose here, this strict hierarchy only holds \textit{within} the boundaries of the region-industry cluster. In particular, (i) the assumption of industry-specific quality attributes for intermediate varieties and; (ii) the presence of an industry- and region-specific spillover mechanism, introduce discrepancies in the ranking of intermediate varieties between firms operating in different regions and/ or industries. Hence, the sourcing strategy of a low productivity firm is not necessarily a subset of the sourcing strategy of a more productive firm operating in a different cluster. It is in fact possible for a low productivity firm to source in equilibrium more (and different) varieties than a firm with higher productivity operating in a different region-industry cluster, achieving a higher sourcing capacity.\textsuperscript{60}

Antràs et al. [2017], promote the heterogeneity of fixed costs of sourcing\textsuperscript{61}

\textsuperscript{50} This is also consistent with the evidence presented in Table 2, which suggests that the extensive margin of sourcing is indeed positively related to firm-level productivity.

\textsuperscript{60} In other words the general hierarchical pattern of sourcing also needs not hold across region-industry clusters.

\textsuperscript{61} Fixed costs of sourcing in their framework are source-market specific as the sourcing decision pertains to selecting a set of source-markets for intermediates.
as a possible explanation for the violation of the strict hierarchy pattern in the data. Their structural estimation results highlight the importance of heterogeneous fixed costs in matching the model to the data. Alternatively, import spillovers arise as an empirically relevant mechanism that when embedded in a framework that is rich enough to account for the interdependences in the firms’ international sourcing decisions, it breaks down the strict hierarchy prediction and yields results that are closer to the data (in this regard) compared to other models in the literature.

In solving for the general equilibrium, I will focus on the case of complementary sourcing decisions since \( \frac{\alpha - 1}{\rho - 1} > 1 \) allows for a closed form solution.\(^{62}\)

2.5 General Equilibrium

The model features free entry:

\[
\int_{\phi_{min}}^{\infty} \left( \phi^{\alpha - 1} B_{rs} \Theta_{s} (\phi)^{\frac{\alpha - 1}{\rho - 1}} - w \sum_{j} f_{jr} (N_{rsj}) \right) dG(\phi) = w f_{rs}^{E} \tag{2.23}
\]

\( \phi_{min} \)\(^{63}\) is the lower bound of the productivity distribution and \( f_{rs}^{E} \) (units of labour) is the cost to enter industry \( s \) in region \( r \). It is only after incurring this cost that firms find out their productivity. The entry cost is thereafter considered to be sunk.

Let the productivity distribution be Pareto, with curvature \( \kappa \) and impose that \( \kappa > \alpha - 1 \). As no fixed costs are associated with sourcing domestically produced intermediate inputs and domestic production, the least produc-

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\(^{62}\) The ‘knife-edge case’ i.e. \( \frac{\alpha - 1}{\rho - 1} = 1 \) is even more straightforward and yields sharper predictions as it mutes interdependences between the sourcing decisions.

\(^{63}\) I assume that \( \phi_{min} = 1 \).
tive firms can survive in the market using exclusively domestically produced intermediates as inputs to their production.\textsuperscript{64}

$\Theta_{iz}(\phi, \Gamma_{iz}(\phi))$ is the sourcing capacity of firm $i$ whose sourcing strategy comprises of the $z$ most appealing varieties. $\Theta_{iz-1}(\phi, \Gamma_{iz-1}(\phi))$ is the sourcing capacity of firm $i$, when $I_j = 1$ for $j = \{1, 2, 3, \ldots, z-1\}$ and $I_z = 0$. Following from (2.22), firm $i$ will include the $z^{th}$ variety in its sourcing strategy, if and only if:

\begin{equation}
\phi_{\sigma-1} \left( \Theta_{iz}^{\sigma - 1} - \Theta_{iz-1}^{\sigma - 1} \right) B_{rs} \geq w f_z(N_{rsz}) \\
\iff \phi_{\sigma-1} \Delta \Theta_{iz}^{\sigma - 1} B_{rs} \geq w f_z(N_{rsz})
\end{equation}

(2.24)

Solving (2.24) for $\phi$, we obtain the productivity cutoff ($\phi_{rsz}^*$) associated with importing the $z^{th}$ variety. $\phi_{rsz}^*$ is the lowest productivity level for which a firm in $\{r, s\}$ can afford to incur the incremental fixed sourcing cost $f_z$ without realising losses (conditional on its previous sourcing decisions).

$$\phi_{rsz}^* = \left( \frac{w f_z(\delta_{rsz} N_{rsz})^{-\beta}}{\Delta \Theta_{rsz}^{\sigma - 1} B_{rs}} \right)^{\frac{1}{\sigma - 1}}$$

(2.25)

The expression in (2.25) is region- and industry-specific reflecting that a variety’s ranking needs not persist across region and industry clusters.

The productivity cutoffs associated with importing any intermediate variety are inversely related to that variety’s sourcing appeal and therefore its respective position in the ranking. In particular, the productivity cutoffs associated with importing the $z^{th}$ and the $(z + \kappa)^{th}$, where $\kappa > 0$, most ‘appealing’ varieties in the ranking will satisfy:

$$\phi_{rsz}^* < \phi_{rsz+\kappa}^*$$

(2.26)

\textsuperscript{64}As no fixed costs are associated with sourcing domestically produced inputs, these are likely to be more accessible compared to foreign inputs.
Equation (2.26) communicates the increased difficulty of sourcing less accessible varieties, which in turn implies that it will only be profitable for more productive firms to include such varieties in their respective sourcing strategies. A greater measure of firms will then include the more accessible (highest ranked) varieties, whereas only the most productive firms would be able to reach out to the lower ranked varieties.

Solving for the general equilibrium involves obtaining the equilibrium expressions for the number of entrants \( N_{rs} \) in the region-industry cluster and for the region-industry market demand term \( B_{rs} \). Combining (2.11), (2.23) and (2.25) we obtain the equilibrium expressions:

\[
N_{rs} = \frac{\sigma - 1}{\kappa \sigma} \frac{\eta_s L_r}{f_{rs}} \quad (2.27)
\]

\[
B_{rs} = \left( \frac{f_{rs} \kappa}{\sigma - 1} \right)^{\frac{\sigma - 1}{\sigma}} \frac{f_{rs} (\sigma - 1 + 1)}{\eta_s \kappa} \frac{1 - \frac{\Delta \Theta_{rsz}}{\kappa(1 - \beta)}}{\sum_{z \in J} \left( \frac{\phi_{rsz}}{\kappa(1 - \beta)} \right)^{\frac{\sigma - 1}{\sigma - 1}} - 1} \quad (2.28)
\]

We can then determine the equilibrium cutoffs associated with each intermediate variety \( \phi_{rsz}^* \) and the respective price indices for each industry and region intersection \( P_{rs} \). Replacing for \( N_{rsz} = (1 - G(\phi_{rsz}^*)) N_{rs} \) in (2.25) we get the equilibrium expression for \( \phi_{rsz}^* \).

\[
\phi_{rsz}^* = \left( \frac{w}{B_{rs}} \right)^{\frac{\sigma - 1}{\sigma - 1}} \frac{f_{rsz} N_{rs} \Delta \Theta_{rsz}}{\kappa(1 - \beta)} \quad (2.29)
\]

We then determine the prevailing cost in region \( r \) for one unit of the composite output of industry \( s \).

\[
P_{rs}^{\sigma - 1} = \frac{\sigma}{\sigma - 1} \frac{\eta_s \kappa L_r}{\eta_s \kappa L_r} \quad (2.30)
\]

The productivity cutoff in (2.29) decreases with the size of the region-industry...
cluster (i.e. the number of firms operating in the region and industry). Therefore, firms operating within a larger cluster will *ceteris paribus* be faced with lower cutoffs for *all* foreign intermediate varieties.\(^{65}\)

The idea that the geographic concentration of same-industry producers induces input suppliers to locate nearby, enabling final goods producers to enjoy access to specialised services and purchase inputs more efficiently, is one of the elements of the Marshallian ‘trinity of agglomeration economies’. Interestingly, Equation (2.29) suggests that there is an international dimension to these ‘input externalities’. Accounting for region- and industry-specific import spillovers implies that the clustering of same-industry firms, facilitates firms’ access to a wider range of both domestic and foreign (imported) intermediates. Given the link between imported intermediates and firm-level productivity, spillovers between importers may be one under-researched factor behind the productivity gains arising from agglomerations.

### 2.6 Spillovers and the margins of global sourcing

I now turn to the study of interactions between the spillover mechanism and the firm’s extensive and intensive margins of trade. To this end, I take ad-

\(^{65}\)This scale effect would not arise in the absence of spillovers (i.e. for \(\beta = 0\)). The presence of such scale effects however results from the modelling assumption that fixed costs depend on the number of same-variety importers in the region-industry cluster and would not arise if we were to have modelled spillovers through linking the fixed sourcing costs with the fraction of importers (instead of the number).

\[
f_z = \tilde{f}_z(b_{rsz}\frac{N_{rsz}}{N_{rs}})^{-\beta}
\]

The respective expression for the cutoff would then be:

\[
\phi_{rsz} = \left(\frac{w}{B_{rs}} \frac{\tilde{f}_z(b_{rsz}\phi_{rsz})^{-\beta}}{\Delta \beta_{rsz}}\right)^{\sigma-1-\sigma \beta}
\]
vantage of the profit function's properties and invoke monotone comparative statics holding constant the market demand term $B_{rs}$. Mind however that the endogenous response of $B_{rs}$, which reflects competitive conditions, can be quantitatively important mitigating the results derived below.

### 2.6.1 Spillovers and the extensive margin of global sourcing

Replacing fixed costs in (2.12) with the spillover mechanism from equation (2.11), we can re-write the firm’s profit maximisation problem to read:

$$\max_{\phi, \Gamma_i(\phi)} \pi(\phi, \Gamma_i(\phi)) = p(\phi, \Gamma_i(\phi))q(\phi, \Gamma_i(\phi)) - C(\phi, \Gamma_i(\phi))q(\phi, \Gamma_i(\phi)) - \sum_{z \in \Gamma_i(\phi)} \tilde{f}_z(z)N_{rsz}^{-\beta}$$

(2.31)

Closer inspection of Equation (2.31), reveals that the objective profit function is *supermodular* in $\theta = \{\phi, \xi_{sz}, \tilde{f}_z, N_{rsz}, \delta_{rsz}, \beta\}$.\(^{66}\) Invoking comparative statics and Topkis monotonicity,\(^{67}\) the supermodularity of (2.31) implies that the firm’s sourcing strategy is weakly increasing in $\theta$.

We can therefore establish the following:

**Proposition 3.** The supermodularity of (2.31) implies that all else equal, the firm’s extensive margin of global sourcing (i.e. its sourcing strategy $\Gamma_i(\phi)$), (weakly) increases with the strength of the spillover mechanism. In particular,

1. a higher $\beta$, i.e. a stronger reaction of the fixed costs to the number of same-variety importers in region-industry cluster $\{r, s\}$, and;

\(^{66}\) $\tilde{f}_z = -f_z$. See Appendix D for a formal proof establishing the supermodularity of equation (2.31).

\(^{67}\) See Appendix D for a formal application.
b. a higher \( \delta_{rsz} \), i.e. a weakening of the decay factors governing the exchange of import-relevant information relating to any variety weakly expand the firms’ extensive margins of global sourcing.

Supermodularity of (2.31), guarantees that flows of import-relevant information between the firms operating in the same region-industry cluster allow the use of a wider range of internationally sourced intermediate product varieties as inputs to the production process.

Assuming that the respective ranking of intermediate varieties in terms of their sourcing appeal is not affected by changes in \( \beta \), an expansion of \( \Gamma_i(\phi) \) will also cause \( \Theta_i(\phi, \Gamma_i(\phi)) \) to increase and thereby the firm-level marginal costs, \( C_i(\phi) \) to fall. This is illustrated in Figure 2.1 below. Keeping the ranking of varieties constant, stronger spillovers allow the firm to move rightwards along the marginal cost curve by ‘stretching’ the sourcing strategy to include more intermediate varieties. Lowering marginal costs, the spillover mechanism becomes relevant for consumer welfare as it is a vehicle for lower consumer prices.

\footnote{Or, that a higher \( \beta \) re-arranges the ranking of intermediate varieties by enhancing the accessibility of varieties with a higher sourcing potential.}
Illustrative simulation of marginal costs as a function of the firm's sourcing strategy for different values of parameter $\beta$ ($\tau = 1.8$, $\kappa = 4.25$, $\sigma = 38$, $\rho = 1.87$)

2.6.1.1 The ‘cost’ of information spillovers on firms’ sourcing decisions

Note however that this is only one of the possible outcomes in such a framework. Spillovers will induce marginal cost reductions so long as a stronger spillover mechanism (a) does not affect the respective ranking of intermediate varieties (and therefore the firms' import behaviour and existing composition of its sourcing strategy) or, (b) leads to a more ‘efficient’ ranking whereby firms' equilibrium sourcing strategies comprise of higher-potential varieties. In the former case, as illustrated above, spillovers lead to lower
marginal costs by enabling firms to expand their sourcing strategy and import a wider range of intermediate inputs. In the latter case, spillovers would enable firms to achieve in equilibrium a better ‘mix’ of intermediates, pushing down the marginal cost curve. However, to the extent that spillovers have an impact on the ranking of intermediate varieties, they could also lead to a ‘less efficient’ ranking in equilibrium by bolstering the appeal of varieties with a lower sourcing potential. In this case, stronger spillovers would push the marginal cost curve upwards. As a result, even if firms would have access to a wider range of intermediates in equilibrium, this would not necessarily translate into lower marginal costs (compared to the case with no spillovers). A stronger spillover mechanism would therefore limit (or even cancel) the cost savings arising from inputs trade.

To fix ideas on this point, consider the response of the fixed costs associated with sourcing any intermediate variety \( z \) to a hike in the the strength of the spillover mechanism as it is summarised by the following elasticity.\(^{69}\)

\[
\epsilon_{f_z}(N_{rsz})|_\beta = -\beta \ln(\delta_{rsz}N_{rs})
\]  

Equation (2.32), demonstrates that all else equal, a stronger spillover mechanism does not affect fixed costs of sourcing associated with different varieties in the same way. In particular, intermediate product varieties for which the exchange of import-relevant information is more straightforward (i.e. varieties characterised by a higher \( \delta_{rsz} \)) will undergo more pronounced reductions in their respective fixed costs following a rise in \( \beta \).\(^{70}\) Since fixed

\(^{69}\) The elasticity is calculated on the expression for the fixed cost of sourcing in (2.11).

\(^{70}\) If on the contrary the scaling parameters \( \delta_{rsz} \) did not have a variety-specific dimension then the respective elasticity would equal \( \epsilon_{f_z}(N_{rsz})|_\beta = -\beta \ln(N_{rs}) \) and all fixed costs of sourcing would decrease symmetrically as a result of a higher \( \beta \).
costs of sourcing are among the determinants of an intermediate variety’s ‘sourcing appeal’ (the only other determinant being the variety’s sourcing potential $\xi_{rs}^{1-\rho}$), a stronger spillover mechanism can directly impact the ranking of intermediate product varieties and hence the sourcing capacity of firms in \{r, s\}. To the extent that a stronger spillover mechanism renders varieties with a lower sourcing potential ‘more attractive’ by asymmetrically lowering their respective fixed costs, the composition of $\Gamma_i(\phi)$ will change reflecting the new ranking. $\Theta_i(\phi, \Gamma_i(\phi))$ will also be affected as firms turn to intermediate product varieties of inferior sourcing potential. It is possible that in equilibrium sourcing capacity declines and marginal costs increase.

The ranking reversals predicted by the proposed theoretical framework are consistent with the empirical findings in Pateli [2018]. The reported results show that the presence of established importers of intermediate product variety $z$ in the region-industry cluster \{r, s\}, renders other firms operating in \{r, s\} more likely to start importing $z$ but at the same time, less likely to start importing the same product from a different source market or a different product from another source market.

Findings are particularly relevant for policy makers. As opposed to gathering information related to exporting activities, public interventions are rare in the case of importing. Subsequently, informal informational transfers across firms may be an important channel for lowering the cost of entry into international markets for intermediates. As discussed in this section, spillovers need not be the most efficient way of sharing import-relevant information.

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71 This would occur if for example intermediate product varieties of low sourcing potential were also linked with high $\delta$s.

72 See Chapter 1, Table 2 of this present thesis.
This is an argument in favour of policies centred on facilitating firms to build their sourcing strategy on the basis of what suits best their production requirements by lowering informational barriers associated with importing.

Another implication of Equation (2.32), is that a stronger spillover mechanism, would induce more pronounced reductions in the fixed sourcing costs associated with any intermediate product variety in bigger region-industry clusters (i.e. clusters featuring a larger mass of firms in equilibrium).

### 2.6.2 Spillovers and the intensive margin of sourcing

Combining (2.16), (2.17) and (2.18), we obtain the optimal firm-level demand for variety $z$.

$$x_{iz} (\phi, \Gamma_i(\phi)) = \frac{1}{p_{z}} (\sigma - 1) B_{rs} e_{b_{sz}}^{p-1} \Theta_i(\Gamma_i(\phi)) \phi^{\sigma-1}$$  \hspace{1cm} (2.33)

Keeping $B_{rs}$ constant, demand for any intermediate variety $z \in \Gamma_i(\phi)$ depends positively on the firm's sourcing capacity\(^{73}\). In the baseline case where a higher $\beta$ increases $\Theta_i(\phi, \Gamma_i(\phi))$, a firm's demand for any variety in its sourcing strategy will go up as a result of a strengthening of the spillover mechanism\(^{74}\).

\(^{73}\)This is true in the complements case where $\frac{\sigma - 1}{\rho - 1} > 1$.

\(^{74}\)In Chaney [2008], a change in fixed costs of exporting only impacts the extensive margin (i.e. the number of equilibrium exporters), whereas changes in variable trade costs affect both the extensive as well as the intensive margins of exporting. Interestingly, in the proposed framework even though spillovers operate via lowering the fixed costs of importing, they affect both margins.


2.7 The nature of spillovers

The modelling of import spillovers in (2.11) assumes that exchanges of import-relevant information between firms are variety-specific and restricted within the boundaries of the region-industry cluster.

It is plausible to think that some components of the fixed costs may be affected by the presence of importers operating both within and outside the firm’s own region-industry cluster. For instance, firms located in the same region but operating in different industries could be carriers of import relevant information that can be diffused via inter-industry linkages. Moreover, as both intra and inter-industry linkages go beyond regional boundaries, we can further consider that firms operating in the same (or a different) industry and are located in different regions, also convey import-relevant information.

A more general formulation of the spillover mechanism expressed in (2.11) would be:

$$f_z(N_z) = \bar{F}_z + \tilde{f}_z \left[ \delta_{rsz} N_{rsz} + \delta_{r-s2z} N_{r-s2z} + \delta_{r-s2} N_{r-s2} + \delta_{-r-s2z} N_{-r-s2z} \right]^{-\beta}$$

(2.34)

By including the term $\bar{F}_z$ in the expression, I acknowledge that some fixed costs components are not spillover-sensitive. An example would be the costs related to compatibility tests taking place within the firm when introducing a new input in the production process.

The first term inside the bracket in (2.34) represents the region- and industry-specific component of the spillover mechanism. The other terms inside the
brackets account for the import relevant informational exchanges occurring outside the region-industry boundaries. \( N_{-rsz} \) stands for the number of importers operating in the same industry but located in any different region and \( \delta_{-rsz} \) is the respective scale parameter. In the same vein, \( N_{r-sz} \) and \( N_{-r-sz} \) represent the number of importers located in the same region but operating in any different industry and the number of importers located in any different region and operating in any different industry respectively.\(^75\)

In (2.34), the relationship between the different scale parameters reveals the relative strength of import-relevant information exchanges occurring through the different channels. For example, \( \delta_{-rsz} < \delta_{rsz} \) implies that import spillovers feature spatial decay.

The expression in (2.11) can be derived from (2.34) by setting \( \bar{F}_z = 0 \) and \( \delta_{-rsz} = \delta_{r-sz} = \delta_{-r-sz} = 0 \). The benchmark spillover mechanism therefore inflicts that the import relevant information entirely depreciates when it ‘travels’ outside the region-industry cluster’s boundaries.

Adopting the formulation in (2.11) i.e. focusing on the spillover-sensitive component of the fixed cost of sourcing and in particular, its region- and industry-specific dimension, allows me to obtain a closed form solution for the model.

Empirical findings in Pateli [2018],\(^76\) provide evidence of intra-industry spillovers and further show that intra-industry spillovers exhibit spatial decay. However, the reported findings also provide evidence in favour of a spillover mechanism operating via inter-industry linkages (buyer-seller re-

\(^75\) \( \delta_{r-sz} \) and \( \delta_{-r-sz} \) are the respective scaling parameters.

\(^76\) See Chapter 1, Table 3.
Chapter 2. Information spillovers & the margins of global sourcing

The theoretical implications of taking into account a richer formulation of import spillovers featuring more dimensions are further discussed below.

Consider for example that the spillover mechanism takes the form of a variety-specific fixed sourcing cost that decreases with the number of importers of that variety, located in the firm’s region and regardless of the industry they operate in.\(^{77}\)

\[
f(N_{rz}) = \tilde{f}_z[\delta_{rsz} N_{rsz} + \sum_{s' \in S, s' \neq s} \delta_{rs'z} N_{rs'z}]^{-\beta} \quad (2.35)
\]

In this context, individual sourcing decisions command that variety \(j\) will be added to the firm’s sourcing strategy iff

\[
\phi^{s-1 - \chi} B_{rsz} \Delta \Theta_{rsz}^{\chi} \geq w \tilde{f}_z[\delta_{rsz} N_{rsz} + \sum_{s' \in S, s' \neq s} \delta_{rs'z} N_{rs'z}]^{-\beta} \quad (2.36)
\]

The inter-industry spillover mechanism links the firm-level sourcing decision to the number of importers of a given variety operating in other industries, rendering the sourcing decision dependent on requirements/characteristics that are not directly relevant to firm \(i\).\(^{78}\) This is because the number of importers of \(z\) in \(\{r, s'\}\), where \(s' \neq s\), depends on the respective ranking of the intermediate varieties within the \(\{r, s'\}\) cluster, which in turn is a function of the market conditions and the size of that cluster, as well as industry-specific quality attributes.

As the determinants of the ranking of intermediate varieties are different

\(^{77}\) In (2.34) above, let \(\bar{F}_z = 0\) and \(\delta_{rsz} = \delta_{rsz} = 0\).

\(^{78}\)
across region-industry clusters, inter-industry spillovers may favour the inclusion of intermediates bearing a lower cost-saving potential for the firm.\footnote{These would be varieties featuring a lower sourcing potential.} This in turn limits the gains arising to consumers from international sourcing.\footnote{Such reversals would also occur if a variety’s quality flow (or the compatibility of an intermediate variety with the firm’s production process) was assumed to be firm-specific. In this case, the ranking of varieties would no longer be the same for all firms in the same region-industry cluster. As a result, in the presence of spillovers firm $i$ will have to factor in its sourcing decisions the requirements of other firms with respect to a given intermediate variety $j$.}

### 2.8 Concluding remarks

The European Commission has recently stated that ‘it is not just exports that are essential to economic growth and job creation but increasingly also imports’. This is unsurprising as trade in intermediates has grown to be a salient part of global trade flows (accounting for more than half of the global trade volume). Moreover, there is growing evidence that importing, via enabling access to a wider range of intermediates, induces productivity gains thus operating as a vehicle for knowledge transfers between countries.

Notwithstanding the relevance of trade in intermediates for domestic productivity, innovation and growth, policy makers have long prioritised export promotion. In many countries public entities (Chambers of Commerce, National Boards of Trade etc.) regularly organise interventions to support firms’ entry into export markets, whereas Embassies through their Trade Offices actively engage in export promotion events.

As opposed to gathering information related to exporting activities, public interventions are rare in the case of importing. Subsequently, informal in-
formational transfers across firms may be an important channel for lowering the cost of entry into international markets for intermediates.

As discussed in this paper, spillovers need not be the most efficient way of sharing import relevant information. Enabling firms to build their sourcing strategy on the basis of what suits best their production requirements is welfare relevant as the gains of global sourcing would be passed on to consumers in the form of lower prices.
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Appendix

A. A firm’s sourcing capacity is non-decreasing in productivity

Proposition 1. The solution to (2.21) is such that the firm’s sourcing capacity $\Theta_i(\Gamma_i(\phi))$ is non-decreasing in $\phi$.

Proof. Consider two firms $i$ and $i'$ located in region $r$ with productivities $\phi_H$ and $\phi_L$ and $\phi_H > \phi_L$. Let $\Gamma_i(\phi_H)$ and $\Gamma_i(\phi_L)$ be the optimal sourcing strategies of these firms, and suppose that $\Gamma_i(\phi_H) \neq \Gamma_i(\phi_L)$. For the high productivity firm to prefer $\Gamma_i(\phi_H)$ over $\Gamma_i(\phi_L)$:

$$\phi_H^{\sigma - 1} \left( \Theta_i(\phi, \Gamma_i(\phi_H)) \right)^{\frac{\sigma - 1}{\sigma}} B_{rs} - w \sum_{j \in \Gamma_i(\phi_H)} f_j(N_{rsj}) >$$

$$\phi_H^{\sigma - 1} \left( \Theta_i(\phi, \Gamma_i(\phi_L)) \right)^{\frac{\sigma - 1}{\sigma}} B_{rs} - w \sum_{j \in \Gamma_i(\phi_L)} f_j(N_{rsj}) \quad (A.1)$$

And for the low productivity firm to prefer $\Gamma_i(\phi_L)$ over $\Gamma_i(\phi_H)$:

$$\phi_L^{\sigma - 1} \left( \Theta_i(\phi, \Gamma_i(\phi_H)) \right)^{\frac{\sigma - 1}{\sigma}} B_{rs} - w \sum_{j \in \Gamma_i(\phi_H)} f_j(N_{rsj}) <$$

$$\phi_L^{\sigma - 1} \left( \Theta_i(\phi, \Gamma_i(\phi_L)) \right)^{\frac{\sigma - 1}{\sigma}} B_{rs} - w \sum_{j \in \Gamma_i(\phi_L)} f_j(N_{rsj}) \quad (A.2)$$

Adding by parts A.3 and A.2:

$$\left( \phi_H - \phi_L \right) \left[ \left( \Theta_i(\phi, \Gamma_i(\phi_H)) \right)^{\frac{\sigma - 1}{\sigma}} - \left( \Theta_i(\phi, \Gamma_i(\phi_L)) \right)^{\frac{\sigma - 1}{\sigma}} \right] > 0 \quad (A.3)$$

Since $\phi_H > \phi_L$ it follows that $\Theta_i(\phi, \Gamma_i(\phi_H)) > \Theta_i(\phi, \Gamma_i(\phi_L))$ ■
B. Complementarities between sourcing decisions and the pecking order of imports

**Proposition 2.** For $\frac{\sigma - 1}{\rho - 1} > 1$, the solution to the optimal sourcing strategy problem delivers a pecking order in the extensive margin of sourcing $\Gamma_i(\phi^L) \subseteq \Gamma_i(\phi^H)$ for $\phi^L \leq \phi^H$.

**Proof.** Whenever $\frac{\sigma - 1}{\rho - 1} > 1$ equation 2.21 features increasing differences in $(I_{ij}, I_{ij}')$, for $j, j' \in 1, 2, \ldots, J$ with $j \neq j'$, but also features increasing differences in $(I_{ij}, \phi)$ for any $j \in J$. By Topkis monotonicity theorem, it follows that if $\phi_H > \phi_L$, we will have that:

$$ (I_{i1}(\phi_H), I_{i2}(\phi_H), \ldots, I_{iJ}(\phi_H)) \geq (I_{i1}(\phi_L), I_{i2}(\phi_L), \ldots, I_{iJ}(\phi_L)) $$

We conclude that $I_i(\phi_L) \subseteq I_i(\phi_L)$ for $\phi_L \leq \phi_H$. ■

**C. Solving for the general equilibrium for $\frac{\sigma - 1}{\rho - 1} > 1$**

The free entry condition is summarised in equation 2.23. Replacing for $dG(\phi) = \kappa \phi^\kappa \phi_{rsz}^\kappa$, we get

$$ \kappa B_{rs} \sum_{z=1}^{J} \Theta_{uz}^\delta (\phi) \int_{\phi_{rsz}^*}^{\phi_{rsz}^*+1} \phi^{\sigma - 1 - \rho} d\phi + w \sum_{z=1}^{J} \hat{f}_z \left[ \delta_{rsz} \phi_{rsz}^\kappa - \kappa N_{rs} \right] = \beta \int_{\phi_{rsz}^*}^{\infty} \kappa \phi_{rsz}^\kappa \phi^{-\kappa - 1} d\phi = w f_{ers} \tag{C.1} $$

replace for the cutoff from (2.24) we get:

$$ \frac{\sigma - 1}{\kappa - \sigma - 1} w N_{rs}^{-\beta} \phi_{rsz}^{\kappa(1-\beta)} \sum_{z=1}^{J} \hat{f}_z \delta_{rsz} \phi_{rsz}^{1-\beta} - \kappa(1-\beta) = f_{ers} \tag{C.2} $$
It also follows that

\[ N_{rs}^{-\beta} \phi_{\min}^{\kappa(1-\beta)} \sum_{z=1}^{f_{rs}} \phi_{rsz}^{\kappa(1-\beta)} + f_{ers} = \frac{K}{\alpha - 1} f_{ers} \]  

(C.3)

Replacing for the cutoff expression from (2.29) in (C.2) and solving for the regional market demand term \((B_{rs})\) we obtain the following expression:

\[ B_{rs} = \left[ w \left( \frac{k^{-\beta} f_{ers}}{\alpha - 1} \right) \right] \]

(C.4)

Equation (C.4) depends on parameters and the equilibrium number of potential entrants in the region-industry cluster \(N_{rs}\).

The average productivity\(^{81}\) of firms in \(\{r, s\}\) that import the \(z\) top ranked intermediate varieties, in other words the average productivity of firms with sourcing capacity \(\Theta_{rsz}\) can be written as:

\[ \phi_{rsz}^{\kappa(1-\beta)} = \int_{\phi_{rsz}}^{\phi_{rsz}^*} \phi^{\kappa(1-\beta)} g(\phi) d\phi = \frac{K}{\kappa - \alpha + 1} \phi_{rsz}^{\kappa(1-\beta)} - \phi_{rsz}^{\kappa(1-\beta)+1} \]

(C.5)

The average productivity of all firms active in the \(r,s\) cluster is then given by

\[ \phi_{rs}^{\kappa(1-\beta)} = \frac{\sum_{z=1}^{f_{rs}} N_{\Theta_{rsz}} \phi_{rsz}^{\kappa(1-\beta)} - \phi_{rsz}^{\kappa(1-\beta)+1}}{N_{rs}} \]

(C.6)

where \(N_{\Theta_{rsz}}\) is the equilibrium number of firms that import the first \([1, 2, 3, \ldots, z]\) varieties, i.e. firms whose productivity lies in the interval \([\phi_{rsz}^*, \phi_{rsz}^{\kappa(1-\beta)+1}]\).

\(^{81}\) A power function of a Pareto distributed variable inherits the Pareto distribution.
Having (C.6) in mind we can get at the following expression:

\[ P_{rs} = \frac{\sigma}{\sigma - 1} \left[ \frac{\kappa}{\sigma - 1} \frac{w}{B_{rs}} N_{rs} \frac{E_{rs}}{f_{rs}} \right]^{1/\sigma} \]  

(C.7)

Combining (C.7) and (2.4) we can solve for the equilibrium number of firms in the region-industry cluster.

\[ N_{rs} = \frac{\sigma - 1}{\kappa \sigma} \frac{\eta_s L_r}{f_{rs}} \]  

(C.8)

Replacing for (C.8) in (C.7)

\[ P_{rs} = \frac{\sigma}{\sigma - 1} \left( \frac{\sigma B_{rs}}{w \eta_s L_r} \right)^{1/\sigma} \]  

(C.9)

Replacing in (2.7) we obtain the overall price index that consumers in region 𝑟 face

\[ P^r = \left( 1 - \sum_{s=1}^{S} \eta_s \right)^{-1} \sum_{s=1}^{S} \eta_s \left[ 1 - \sum_{s=1}^{S} \eta_s \prod_{s}^{S} \eta_s \right]^{1/\sigma - 1} \left( \frac{\sigma B_{rs}}{w \eta_s L_r} \right)^{1/\sigma} \]  

(C.10)

D. Supermodularity
Proof of Proposition 3

Consider \( z = (x, \theta) \) where \( x \) is a control variable and \( \theta \) is a parameter. Function \( f : \mathbb{R}^2 \to \mathbb{R} \) is supermodular in \( (x, \theta) \) if and only if for \( x_0 \leq x^* \) and \( \theta_0 \leq \theta^* \)

\[ f(x^*, \theta^*) - f(x_0, \theta^*) \geq f(x^*, \theta_0) - f(x_0, \theta_0) \]  

(D.1)

It therefore follows that

\[ g(\theta) = f(x^*, \theta) - f(x_0, \theta) \]  

(D.2)

is increasing in \( \theta \).

Moreover, if \( f \) has (possibly appropriately one-sided on boundary points)
cross derivatives the following statements are equivalent:

a. \( f \) is supermodular

b. \( D_x f(x^* \theta^*) \) is weakly increasing in \( \theta \) for every \( x^* \)

c. \( D_\theta f(x^*, \theta^*) \) is weakly increasing in \( x^* \) for every \( \theta \)

d. \( D_{x \theta} f(x^*, \theta^*) \geq 0 \forall (x^*, \theta^*) \)

Supermodularity also implies that:

\[
S(\theta) = \arg\max_{x \in C} f(x, \theta)
\]  
(D.3)

where \( C \) a sublattice of \( \mathbb{R}^N \); is weakly increasing in \( \theta \).

Going back to equation (2.31) we note that we cannot establish continuity as the control variables are discrete indicator variables. However we proceed as follows. Extend the function by allowing the discrete variables to assume their values on \([0,1]\). If we establish (4) for the extended function then we will have obtained supermodularity for the original restricted function since this is obviously a property invariant to restriction.

a. \( D_{iz} \phi = (\sigma - 1) \frac{\sigma - 1}{\rho - 1} \phi^{\sigma - 1} \left( \sum_{z=1}^{J} I_{iz} \xi_{sz}^{\rho - 1} \right) \xi_{sz}^{\rho - 1} B_{rs} \geq 0 \)

b. \( D_{iz} \xi_{sz} = (\rho - 1) \frac{\rho - 1}{\rho - 1} \phi^{\rho - 1} \left( \sum_{z=1}^{J} I_{iz} \xi_{sz}^{\rho - 1} \right) \xi_{sz}^{\rho - 1} B_{rs} \times \)

\[
\left(1 + \left(\frac{\sigma - 1}{\rho - 1} - 1\right) \xi_{sz}^{\rho - 1} \sum_{z=1}^{J} I_{iz} \xi_{sz}^{\rho - 1}\right)^{-1} \geq 0 \text{ for } \frac{\sigma - 1}{\rho - 1} > 1
\]

c. \( D_{ij} f_z = w(\delta_{rsz} N_{rsz} \beta \geq 0, \text{where } f_z' = -f_z \)

d. \( D_{iz} N_{rsz} = \beta w f_z (\delta_{rsz} N_{rsz})^{-\beta} \frac{1}{N_{rsz}} \geq 0 \)
e. \[ D_{t,s} \delta_{rsz} = \hat{\beta} w f_z(\delta_{rsz} N_{rsz})^{-\hat{\beta} \frac{1}{\delta_{rsz}}} \]

f. \[ D_{t,s} \beta = w f_z(\delta_{rsz} N_{rsz})^{-\hat{\beta} \log(\delta_{rsz} N_{rsz})} \geq 0, \] when there is a sufficient ‘effective mass’ of firms such that \[ \delta_{rsz} N_{rsz} \geq 1. \] The term ‘effective mass’ refers to the mass of importers once we account for the fraction of information that is lost when it surpasses the firm’s boundaries.

We have therefore established that the objective function in (2.31) is supermodular in \[ \theta = \{ \phi, \xi_{sz}, f_z', N_{rsz}, \delta_{rsz}, \beta \}. \] We can then invoke (D.3) and establish that the firm’s sourcing strategy \( \Gamma_i(\phi) \) is weakly increasing in \( \theta \).

**E. Discussing key assumptions**

This is a highly stylised framework and a number of assumptions admit further justification. I further analyse the key assumptions in more depth and discuss their implications for the model’s qualitative predictions.

**The variety margin of international sourcing**

The theoretical framework is built on the assumption that fixed costs of international sourcing vary among varieties and therefore depend both on country-level and product-level characteristics.

Antràs et al. [2017], treat fixed costs of sourcing as being country-specific.\(^{82}\)

Their assumption is motivated by (a) the fact that the relative size of premia of American importers vs. non-importers are increasing in the number of countries from which they source and; (b) the existence of considerable

\(^{82}\)They do however clarify that including product-specific fixed costs of sourcing would not alter their results.
discrepancies in the ranking of origin markets based on the number of firms importing from a given country (i.e. the extensive margin of sourcing) vs. the value of imports (i.e. the intensive margin of sourcing). The authors interpret (a) as being suggestive of sizeable country-level fixed costs and (b) as being suggestive of the heterogeneity in fixed costs across origin markets.

Regarding (a), Table 2.3 shows that higher performing firms tend to source more product-country combinations. Thus, we can establish that at least for Swedish data, the differences between importers and non-importers are increasing along the variety margin of international sourcing.

In their paper Antràs et al. [2017], assume that all final-goods producers combine a measure one of inputs in production. Given that the intermediate bundle used in the production process is fixed and motivated by the empirical finding that firms in American data tend to source a single variety of each intermediate product, their theoretical framework restricts the firms’ sourcing decisions to the country dimension. In other words, the determination of the firms’ sourcing strategy consists in deciding the set of countries the firms will source their input requirements from. The evidence presented in Table 2.2, suggests that at least the top 25% of importers source multiple varieties per product. Moreover, the evidence in Table 2.4, implies that there are systematic differences between firms that source multiple varieties per product and firms that source a single variety per product. Thus, focusing exclusively on the country component may be muting an important dimension of the firm-level sourcing decisions.

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83 Blaum et al., 2017[b], cite similar patterns for French data.
The production function

The model distinguishes between intermediate products and intermediate product varieties. Products are differentiated by their country of origin with respect to their quality (and compatibility) attributes.

This distinction is however not fully embedded in the production function (2.8). In the absence of a nested functional form, there is no effective distinction between products and product varieties. Indeed, all product-country combinations are treated as distinct inputs in $i$’s production function. A relatively unrealistic implication of this assumption is that the degree of substitutability (as it is expressed by the elasticity of substitution, $\rho$) between two varieties of the same product (e.g. fabric dye from India and fabric dye from Lithuania) would be the same as between two varieties of different products (e.g. fabric dye from India and electrical car parts from China).

Alternatively, the following functional form could be considered.

$$g_i(\phi) = \phi f(x_{ik})$$  \hspace{1cm} (E.1)

where

$$x_{ik} = g_{ik}(v_{ij} z_{ij})$$  \hspace{1cm} (E.2)

Both $f$ and $\{g_k\}_k$ stand for constant returns to scale production functions. With a nested functional form like the one described in (E.2), the marginal rate of substitution between any two varieties within the same product class would not depend neither on the production function $f$, nor on the demand for different products $x_{k'}$ nor on the technology in different product classes $g_{k'}$. Consistent with our notation $k, k'$ are elements of the product space.
Moving away from the nested form and adopting a production function like (2.8) implies that the marginal rate of substitution between any two varieties (either of the same or different products) would only depend on variety- and sector-specific characteristics. Moreover, expenditure shares of any variety $j$ would be equalised across firms within the same industry sharing the same sourcing strategy.

Despite any conceptual oddities, this modelling assumption allows us to reduce the dimensionality of the firm’s sourcing decisions without however compromising the generality of the proposed framework. It therefore grants the model greater tractability, in particular in the face of the spillover mechanism, at little cost.

An additional advantage of the proposed framework is that it can be directly applied to the data.
3

When do devaluations pay?
3.1 Introduction

Although movements of nominal and real exchange rates are large, we observe relatively little response of trade flows to exchange rate fluctuations. The elasticity of aggregate exports with respect to real exchange rates is typically low in industrialised countries.\(^1\) One way to reconcile these findings with standard theory is to assume very inelastic demand for foreign goods.\(^2\) Such low elasticities though are not consistent with the evidence on the impact of trade liberalisations on trade flows.\(^3\) To explain this puzzling relationship between devaluations and export performance, this paper turns to intermediate import dependence and proposes a tractable framework that accommodates some well documented facts of the international trade literature on the characteristics of exporters, while taking into account trade in intermediate inputs, which is a salient part of global trade flows representing more than half of the volume of global trade.\(^4\) Moreover, dependence

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\(^1\) For example, Hooper et al. [2000] find the elasticity of aggregate exports to be a bit below unity for the G-7 countries.

\(^2\) This is the assumption behind the J-curve. With inelastic demand in the short run, a devaluation may have a negative impact on the current account before the competitiveness effects kick in and exports catch up.

\(^3\) Trying to reconcile these facts, Ruhl [2008] argues that since exchange rates are mean reverting, high frequency variations only incite negligible adjustments along the extensive margin. This can explain why contrary to variations in tariffs or quotas, exchange rate fluctuations seem to have little impact on trade flows.

\(^4\) IMF data
on foreign intermediates is an important feature of the verticalisation of the production process at the global scale. Hence, this approach brings together two of the most influential strands of recent research in the field, namely firm heterogeneity and the interdependence of the final production process across different countries.

There are several papers that are dealing with different aspects of the relationship between exchange rate movements and export performance. One strand of this literature focuses on the interplay between financial market imperfections and firm heterogeneity as the reason behind the contained response of exports to real exchange rate movements. In particular, Chaney [2016] argues that, in an environment where exporters are credit constrained and face fixed costs denominated in foreign currency, a depreciation affects firm-level export decisions in two conflicting ways. First, consistent with the predictions of the traditional theories, a depreciation raises sales inducing more entry. Second, a depreciation by reducing the relative value of self-finance contains entry and it may even induce exit generating a lack of reaction of the extensive margin, which helps explain the international elasticity puzzle. Other examples include Berman and Berthou [2009]; Colacelli [2010].

Other papers have looked at the pass-through of exchange rate movements to international prices and pricing-to-market as possible explanations for the

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5 A number of papers investigates firm-level reactions to exchange rate shocks. Indicatively, Gourinchas [1999] assesses the impact of exchange rate fluctuations on inter- and intra-sectoral reallocations of jobs; Forbes [2002] examines the impact of 12 major devaluation events spanning the period between 1997 and 2000 on several measures of firms’ performance; Ekholm et al. [2012] study firm-level adjustments in terms of employment, productivity and off-shoring in response to an appreciation of the Norwegian krona (NOK) in the early 2000s.

6 See Bonfiglioli [2016] for a discussion of the proposed mechanism.
mixed evidence on the effect of exchange rate movements on firms’ exports. For example, Amiti et al. [2014], merge an oligopolistic competition model of variable markups drawing on Atkeson and Burstein [2008] and a model of the firm’s choice to import intermediate inputs as in Halpern et al. [2015] and generate theoretical insights on the determinants of the exchange rate pass-through. The authors focus on the fact that the largest exporters are simultaneously the largest importers and hence set high markups and actively move them in response to changes in marginal costs limiting the effect of exchange rate shocks on export prices. Relatedly, but focusing instead on the importance of firm productivity and size as the determinants of the variation in pass-through across heterogeneous firms, Berman et al. [2012], using a panel dataset of French firms, find that high-performance firms react to a devaluation by increasing significantly more their markup and by increasing less their export volume. Since aggregate exports are concentrated on high-performance firms, heterogeneous pricing-to-market can explain the weak impact of exchange rate movements on aggregate exports.

A number of papers has focused directly on the intermediate import dependence. In a recent paper, Ahmed et al. [2015] attempt to further unpack the link between the exchange rate movements, international sourcing and exports. They use data from 46 countries over the period 1996-2012 to investigate whether cross-border production linkages are responsible for reducing the effectiveness of depreciations to boost exports and find evidence that the real exchange rate elasticity of (manufacturing) exports has decreased over time. The authors distinguish between the supply-side mechanisms of global value chains (backward linkages, i.e. foreign value added embodied in gross

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7 See among others Campa and Goldberg [2005] and Gopinath and Rigobon [2008].
exports) and forward linkages (i.e., domestic value added exported in intermediates re-exported to third countries). In the presence of the former, competitive gains of depreciations are limited as production linkages imply that the cost of imported intermediate inputs used in final-good production goes up. In the latter, a depreciation increases the competitiveness of downstream producers abroad, stimulating demand for their goods. Their results suggest that the rise in global value chains accounts for approximately 40% of the fall of the RER elasticity of exports.

The backward linkages channel has already attracted the attention of the literature. For example, Greenaway et al. [2010], using measures of exchange rates that capture exposure to changes in the price of imported inputs for U.K. manufacturing firms find that exchange rates have no significant effect on firm exports. Ahn et al. [2017] offer further insights by providing strong evidence on the pass-through of imported input prices to domestic producer prices. The authors apply an error correction model specification to sector-level monthly frequency data and estimate the pass-through to be around 70% in Korea and almost 100% in selected European countries.8

The 'forward linkages' channel has not received any attention. I therefore contribute to the literature on real exchange rate movements and export performance by bringing attention to a rather intuitive mechanism. The main prediction of the model is that in the presence of trade in intermediate inputs, a country's relative intermediate import dependence and the relative use of domestic versus foreign intermediates in the final production process (with respect to its trade partners) arise as key determinants of the

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8 Previous papers (see for example Gopinath and Rigobon, 2008) find low level of exchange rate pass through into import prices.
final goods producers’ export status and export performance. In this context, exchange rate fluctuations, or in general fluctuations of relative prices, may yield results that come at odds with the predictions of the standard, competitive trade theories. The model provides clear-cut conditions for which devaluations don’t enhance the relative cost-competitiveness of the devaluing country leading to a loss of export revenue both at the firm and at the aggregate level and a negative adjustment along the extensive margin of trade. Since the domestically produced intermediates are also used by final goods producers in the foreign country, the competitiveness gains of a depreciation spill over to the foreign country. In this respect, the proposed model also relates to the literature on trade in value added (see Johnson and Noguera [2012]).

Fully understanding the relationship between real exchange rate movements and trade has always been of particular interest to the academia and policy makers, even more so in periods of imbalances. The proposed theory may tell a story and explain why economies in such an integrated global environment featuring interdependencies in the final production process, may not be able to translate material adjustments of the real exchange rate into cost-competitiveness gains of comparable magnitude and enhance their export performance.9

The remaining of this paper is structured as follows: Section 3.2 describes the economy, Section 3.3 solves for the General Equilibrium, Section 3.4 discusses how devaluations affect firm-level export decisions, export performance, aggregate exports and welfare and Section 3.5 concludes.

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9 See Böwer et al. [2014].
3.2 The economy

There are two countries in the world, Home and Foreign. In every country, economic activity is organised around three productive functions: (i) the production of a homogeneous, non-manufacturing good (numéraire); (ii) the production of intermediate inputs and; (iii) the production of final goods (manufacturing sector).

3.2.1 Preferences

Each country is endowed with $L_c$ units of labour, $c = \{h, f\}$. The representative consumer’s preferences are defined over the consumption of both a homogeneous good ($q_c^0$) and the composite output of each country’s manufacturing sector ($Q^c, Q_c'$, where $c, c' \in \{h, f\}$ and $c \neq c'$). In terms of notation, the subscript denotes the country where production takes place and the superscript the country where consumption occurs. The consumer’s upper tier utility takes a familiar Cobb-Douglas form:

$$U^c = (q_0^c)^{\mu} (Q^c)^{1-\mu} \quad (3.1)$$

where $Q^c = \left( Q_c^{\frac{\mu+1}{2}} + Q_c'^{\frac{\mu+1}{2}} \right)^{\frac{2}{\mu+1}}$. The introduction of the numéraire good ($q_0^c$) allows me to close the model while abstaining from the endogenous determination of wages, which is beyond the scope of this exercise. It is produced by perfectly competitive firms, using labour as the only input, subject to a country-specific technology and is freely traded between countries. Per-

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10 We can think of Foreign as representing the rest of the world.
11 The letter $h$ stands for the Home country and respectively the letter $f$ stands for the Foreign country.
12 The country of production is inconsequential for the numéraire good and therefore the country subscript is dropped.
fect competition implies that the price of the numéraire good in each country is \( p_0^c = \frac{w_c}{\phi_0^c} \), where \( w_c \) is the wage rate prevailing in country \( c = \{h, f\} \) and \( \phi_0^c \) stands for the labour productivity in this sector in country \( c \). Provided that \( \mu \) is sufficiently large to ensure that the numéraire good is produced in both countries, free trade leads to the equalisation of the domestic and foreign prices, pinning down relative wages to relative productivities in this sector.\(^{13}\)

The real exchange rate \( R \), is defined as the relative real wage.\(^{14}\) This formulation is akin to the one used by Chaney [2016],\(^{15}\) Berman et al. [2012],\(^{16}\) as well as Atkeson and Burstein [2008].

\[
R = \frac{w_c'}{w_c} \quad (3.2)
\]

Consumer preferences for the domestic and the foreign manufacturing composites are defined over the consumption of individual product varieties according to a standard, symmetric CES aggregator.

\[
Q_c = \left( \int_{z \in \mathbb{Z}_c} q_c(z)^{\frac{1}{\sigma} - 1} dz \right)^{-\frac{1}{\sigma - 1}} \quad Q_c' = \left( \int_{z \in \mathbb{Z}_{c'}} q_{c'}(z)^{\frac{1}{\sigma} - 1} dz \right)^{-\frac{1}{\sigma - 1}} \quad (3.3a)
\]

\[
Q_c' = \left( \int_{z \in \mathbb{Z}_c} q_c(z)^{\frac{1}{\sigma} - 1} dz \right)^{-\frac{1}{\sigma - 1}} \quad (3.3b)
\]

\(^{13}\) We need to assume that \( \mu \) is large enough to guarantee that the commodity good is produced in both countries. In Helpman et al. [2004], the homogeneous non-manufacturing sector is modelled under the symmetry assumption, hence free trade equalises prices as well as factor payments. If unit labour requirements are different across countries though, free trade equalises prices and pins down relative wages to relative productivities in this sector.

\(^{14}\) Under this definition, fluctuations in the real exchange rate are tantamount to changes in relative productivities in the numéraire sector.

\(^{15}\) In Chaney [2016], the real exchange rate is also defined as the relative real wages in different countries and is pinned down by the productivities ratio in the numéraire sector.

\(^{16}\) In Berman et al. [2012], the real exchange rate of the Home country with respect to country \( i \) is given by \( \epsilon_i \frac{w_i}{w} \). \( \epsilon_i \) is the nominal exchange rate between the Home country and its partner \( i \) expressed as units of Home’s currency in terms of units of \( i \)’s currency, \( w_i \) is the wage rate in country \( i \) and \( w \) the wage rate in the home country. Their definition is identical to mine if \( \epsilon_1 = 1 \).
\( \sigma > 1 \) is the elasticity of substitution between any two final good varieties, domestic or foreign and \( Z_c, Z_{c'} \), represent the measure of final product varieties produced in each country \( c, c' \). Solving the consumer’s problem, we obtain the utility maximising demand in country \( c \) for each final good variety \( z \), domestic or imported (foreign).

\[
q_c^c(z) = A_c p_c^c(z)^{-\sigma} \quad (3.4a) \quad q_c^{c'}(z) = A_c p_c^{c'}(z)^{-\sigma} \quad (3.4b)
\]

\( p_c^c(z) \) is the price consumers in country \( c \) pay for any domestically produced manufacturing variety \( z \in Z_c \) and \( p_c^{c'}(z) \) is the price charged to consumers in country \( c \) for any imported manufacturing variety \( z \in Z_{c'} \). \( A_c \) represents an index of market demand that proportionately scales consumer demand for manufacturing goods in country \( c \) and is defined as:

\[
A_c \equiv (1 - \mu) w_c L_c^\sigma (P^c)^{\sigma - 1} \quad (3.5)
\]

\( P^c \) is the price consumers in country \( c \) pay for one unit of the manufacturing aggregate \( Q^c \).

\[
P^c = \left[ \int_{z \in Z_c} p_c^c(z)^{1-\sigma} \, dz + \int_{z \in Z_{c'}} p_c^{c'}(z)^{1-\sigma} \, dz \right]^{\frac{1}{1-\sigma}} \quad (3.6)
\]

Consumer welfare \( W_c \), increases with the range of final product varieties available to the consumer.\(^{18} \) The denominator in (3.7) stands for the consumer price index in country \( c \).

\[
W_c = \frac{w_c}{(p_0^c)^{\mu} (P^c)^{1-\mu}} \quad (3.7)
\]

\(^{17} \left[ \int_{z \in Z_c} p_c^c(z)^{1-\sigma} \, dz \right]^{\frac{1}{1-\sigma}} \) is the price that consumers in \( c \) incur to acquire one unit of \( Q_c^c \) and respectively \( \left[ \int_{z \in Z_{c'}} p_c^{c'}(z)^{1-\sigma} \, dz \right]^{\frac{1}{1-\sigma}} \) is the price that consumers in \( c \) incur to acquire one unit of \( Q_{c'}^{c'} \).

\(^{18} \) The expression in (3.7) is commanded by the upper tier Cobb-Douglas aggregation of sector-level consumption into utility.
3.2.2 Production technology and market structure

In each country $c$, there is a competitive fringe of firms that can potentially enter the manufacturing sector incurring a fixed entry cost ($f_E$) that is thereafter sunk. The timing and structure of Melitz [2003] apply. Upon entry, firms gain ownership of a 'blueprint' that entitles them to the production of a unique, horizontally differentiated variety of the composite final good. After incurring $f_E$, the firms gain access to a productivity draw from a (common) productivity distribution,\(^\text{19}\) which is assumed to be Pareto\(^\text{20}\) with curvature (shape) parameter $\kappa > \sigma - 1$ and scale parameter $\phi_{\min} = 1$. The core productivity parameter $\phi$ is firm-specific, reflecting variation in ability across firms and is time-invariant.

Final goods production in country $c$, combines domestic and foreign intermediates in a composite bundle $X_c$. Dependence on imported intermediates, which is a salient feature of the interconnected global economy,\(^\text{21}\) is therefore embedded in the model. Each country specialises in the production of a single intermediate good for which it is the unique supplier globally.\(^\text{22}\) The

\(^{19}\)The productivity distribution is assumed to be the same for both countries.

\(^{20}\)As in Helpman et al. [2004], Chaney [2016] and Arkolakis et al. [2008, 2012]. The Pareto distribution provides a good fit to the observed productivity distribution of firms and allows for closed form solutions. In Melitz [2003] there is no explicit assumption for the productivity distribution.

\(^{21}\)EU-28 total intermediate import dependency i.e. the share of extra-EU imports in the direct material input to the EU-28 economy stood at 23% for 2016 (the latest available data), according to Eurostat. This share varies across countries and industries.

\(^{22}\)Alternatively, the model could assume that each country produces a unique bundle of intermediate products. Relatedly, we could relax the assumption that each intermediate good or intermediate bundle is produced in only one country and assume instead that intermediates are differentiated by the country of origin and that within the same product class intermediates produced in different countries are seen as imperfect substitutes from the final goods producers' perspective. The proposed framework aims to deliver predictions for firm-level exporting activity in an environment featuring intermediate import dependence but does not examine the sources of intermediate import dependence. Hence, more complex formulations of intermediates production are inconsequential for the qualitative predictions of the model.
intermediate sector operates under perfect competition\footnote{In the same vein, the model could instead incorporate a monopolistically competitive intermediate sector with a fixed mass of firms. Again, as the import decision is not endogenous and I am not interested in further studying the determinants of the set of intermediate inputs available in equilibrium, I have simplified the framework normalising the intermediates sector.} using labour as the only input. The price of $I_c$ (i.e. the domestically produced intermediate) charged on the domestic market is equal to:

$$p^c_{c(I_c)} = \frac{w_c}{\phi^c_I} \quad \quad (3.8)$$

where $1/\phi^c_I$ is the unit labour requirement in the intermediates sector in country $c$. International trade in intermediates is subject to variable, iceberg type costs $\tau > 1$. These costs are assumed to be symmetric (i.e. $\tau_{c,c'} = \tau_{c'c} = \tau$ for $c', c = \{b, f\}$ and $c' \neq c$) and product-invariant i.e. any product (intermediate input or final good) shipped from country $c$ to country $c'$ is burdened with the same variable trade cost. Hence, the price final goods producers based in country $c$ pay for the imported intermediate input is:

$$p^c_{c'(I_{c'})} = \tau \frac{w_{c'}}{\phi^c_{I}} = \tau p^c_{c'(I_{c'})} \quad \quad (3.9)$$

Equation (3.10), summarises the firm’s production technology. As the focus is on intermediate import dependence, all other factors of production (capital and labour) have been muted.\footnote{In Appendix S.1 I explore an alternative formulation for the production function also accounting for the use of labour. The qualitative predictions of the proposed framework are not affected.} Therefore, the firm-level core productivity $\phi$, governs the mapping between the composite intermediate bundle and the production of final goods and summarises all sources of heterogeneity in revenue (relative to intermediate inputs) across firms.

$$y_c(\phi) = \phi X_c \quad \quad (3.10)$$
\[ X_c = \bar{\alpha}_c (I_c)^{\alpha_c} (I_c')^{1-\alpha_c} \]  

(3.11)

where \( \bar{\alpha}_c \equiv \alpha_c^{-\alpha_c} (1-\alpha_c)^{-(1-\alpha_c)} \). The Cobb Douglas formulation in (3.11) posits that domestic and foreign intermediates are both essential for final goods production.25

A key modelling assumption is that the composite production factor \( X_c \) is assembled according to a country-specific technology. Home and Foreign differ in the way they combine domestic and imported intermediates for final goods production i.e. their dependence on imported intermediates.26 Within each country though there is no firm-level heterogeneity with regard to intermediate import dependence.27 The cost all final goods producers in country \( c \) incur to assemble one unit of the composite intermediate \( X_c \) is:

\[ P^F_c = \left( \frac{p^F_c(I_c)}{\tau_p^F(I_c')} \right)^{\alpha_c} \]  

(3.12)

The marginal cost of production for any final goods producer with productivity \( \phi \) based in country \( c \) is:

\[ C_c(\phi) = \frac{1}{\phi} P^F_c \]  

(3.13)

25 \( y_c(\phi) = 0 \) if either \( I_c = 0 \) or \( I_c' = 0 \). In Section S.2 in the Appendix, the composite factor of production \( X_c \), is assembled according to a CES aggregator. Results are not qualitatively affected.

26 It is beyond the scope of this exercise to explain why countries differ in their degree of reliance to foreign intermediates.

27 Note that in the data we actually observe that more productive firms import more intermediates. The focus of this exercise is to investigate firms’ export decisions in the presence of intermediate import dependence. The micro-foundation of firm-level sourcing decisions is however not addressed here. Allowing for heterogeneity in firm-level international sourcing behaviour would imply that a depreciation no longer affects firms of different productivity symmetrically.
3.2.3 The firm’s problem

The firm’s problem in country $c$ consists in determining the profit maximising prices on the domestic and export markets, taking aggregate demand (from consumers at home and abroad) for its products to be given.

$$
\max_{p_c(z)} \pi_c(z) = p_c(z)q_c(z) + \mathcal{I}p_{c'}(z)q_{c'}(z) - \frac{p_c}{\phi} \left( q_c(z) + f_D + \mathcal{I} \left( q_{c'}(z) + f_X \right) \right)
$$

\hspace{1.5cm} (3.14)

\hspace{1.5cm} s.t. \quad q_c(z) = A_c(p_c(z))^{-a} \quad \text{and} \quad q_{c'}(z) = A_{c'}(p_{c'}(z))^{-a}

where $\pi_c(z)$ represents the aggregate profits that the producer of final product variety $z$ earns. $\mathcal{I} = \{0,1\}$ is an indicator variable taking the value of one if the firm based in country $c$ exports to country $c'$. $q_c(z)$ and $q_{c'}(z)$ are determined residually in the consumer’s problem (see equations 3.4).

The modelling postulates that the composite factor is used to cover the fixed entry cost ($f_E$), the fixed costs of production ($f_D$) but also the fixed export costs ($f_X$).\textsuperscript{28} Moreover, I assume that the fixed cost of accessing the domestic market is incorporated into the fixed cost of production ($f_D$).\textsuperscript{29} As a result, all exporters also serve the domestic market (i.e. there is no firm that exports but is not operating on the domestic market). Export profits are therefore over and above the profits realised in the domestic market, which allows us to approach the firm’s domestic and export problems inde-

\textsuperscript{28} The international trade literature has established that entry into export markets is associated with market access costs that do not depend on the volume traded. In order to engage in international activities firms incur significant upfront costs, which are in addition to per-unit costs such as transport costs and tariffs. The modelling of fixed costs goes back to Roberts et al. [1995], Roberts and Tybout [1997], Clerides et al. [1998], Bernard and Jensen [1999], Melitz [2003] and others.

\textsuperscript{29} As it is common in the literature building on the Melitz [2003] framework.
pendently. Equation (3.14) can hence be re-written as:

$$\pi_c(z) = p_c(z)q_c(z) - \frac{P_c}{\phi} (q_c(z) + f_D) + I \left[ p_c(z)^\prime q_c(z)^\prime - \frac{P_c}{\phi} \left( q_c(z)^\prime + f_X \right) \right]$$

(3.15)

### 3.2.3.1 The domestic market problem

Solution to the domestic market component of the firm’s profit maximisation problem\(^{30}\) yields the price \(p_c(z)\)\(^{31}\) that producer of final product variety \(z\) (with productivity \(\phi\)) based in country \(c\) charges on the domestic market.

$$p_c(\phi) = \frac{\sigma}{\sigma - 1} \frac{P_c}{\phi} = \frac{\sigma}{\sigma - 1} C_c(\phi)$$

(3.16)

The quantity of each variety \(z\) that domestic final goods producers with productivity \(\phi\) supply to their home market in order to satisfy demand from domestic consumers is:

$$q_c(\phi) = A_c \left( \frac{\sigma}{\sigma - 1} \frac{P_c}{\phi} \right)^{-\sigma}$$

(3.17)

Equations (3.18) and (3.19) represent the revenues and profits that domestic final goods producers earn on their home market:

$$r_c(\phi) = A_c \left( \frac{\sigma}{\sigma - 1} \frac{P_c}{\phi} \right)^{1-\sigma}$$

(3.18)

$$\pi_c(\phi) = B_c \phi^{\sigma - 1} - P_f f_D$$

(3.19)

\(^{30}\)The domestic market component of the firm’s problem can be derived from (3.15) by setting \(I = 0\).

\(^{31}\)Firm performance measures solely depend on the firm’s core productivity parameter \(\phi\), i.e. any two producers sharing the same level of productivity will charge the same prices, supply the same output quantity, earn the same revenues and profits regardless of the variety they produce. I will hence index everything in terms of productivity instead of variety \(q_c(\phi), r_c(\phi), \pi_c(\phi), p_c(\phi)\).
where \( B_c \) is a function of the market demand index \( A_c \):\(^{32}\)

\[
B_c = \frac{1}{\sigma} A_c \left( \frac{\sigma}{\sigma - 1} P_f^c \right)^{1-\sigma} \quad (3.20)
\]

Constant markups and homothetic production technology imply that variable gross profits can be expressed as a constant fraction of revenues, i.e. \( \pi^c(\phi) + P_f^c f_D = \frac{\tau^c(\phi)}{\alpha} \). Results are consistent with the bulk of empirical findings in the literature,\(^{33}\) i.e. more productive firms charge lower prices, are of bigger size, earn higher revenues and profits and have a higher intermediate input requirement.

For a firm to ‘survive’ on the domestic market in the presence of fixed production costs it should be productive enough to realise non-negative profits \( (\pi^c(\phi) \geq 0) \). Rearranging (3.19) we obtain \( \phi^*_c \), i.e. the minimum productivity required in order to remain active on the domestic market. In following sections, \( \phi^*_c \) will be referred to as the domestic ‘survival cutoff’.

\[
\phi^*_c = \left( P_f^c B_c^{-1} f_D \right)^{\frac{1}{\sigma}} \quad (3.21)
\]

### 3.2.3.2 The export market problem

Final goods trade is subject to both variable \((\tau > 1)\) and fixed export costs \((f_X)\). Solving the exporter’s problem, we obtain the price \((p_c^c(\phi))\) that domestic producer with core productivity \(\phi\) charges on the export market \((c')\) and the quantity \((q_c^c(\phi))\) supplied in order to satisfy foreign consumers’ de-

\(^{32}\)As it can be seen in (3.18) and (3.19) the market demand index \( A_c \) proportionally scales both revenues and gross profits.

\(^{33}\)As summarised in the reference paper of Bernard et al. [2003], but also the literature review of Bernard et al. [2011].
mand.\textsuperscript{34}

\[
\begin{align*}
    p'_{c}(\phi) &= \tau \frac{a}{a-1} \frac{P_{I}'}{\phi} = \tau p_{c}'(\phi) \\
    q'_{c}(\phi) &= A_{c'} \left( \frac{\sigma}{\sigma-1} \frac{P_{I}'}{\phi} \right)^{-\sigma} \\
    \end{align*}
\]

(3.22)\textsuperscript{34}

The revenues \( r'_{c}(\phi) \) and profits \( \pi'_{c}(\phi) \) earned on the export market are given by:

\[
\begin{align*}
    r'_{c}(\phi) &= A_{c'} \left( \frac{\sigma}{\sigma-1} \frac{P_{I}'}{\phi} \right)^{1-\sigma} \\
    \pi'_{c}(\phi) &= B_{c'} \left( \frac{P_{I}'}{P_{I}'} \right)^{1-\sigma} \phi^{\sigma-1} - P_{c} f_{X} \\
    \end{align*}
\]

(3.23)\textsuperscript{34}

(3.24)\textsuperscript{34}

(3.25)\textsuperscript{34}

where \( A_{c'} = (1 - \mu)w_{c}L_{c}(P_{c})^{\sigma-1} \) and \( B_{c'} = \frac{1}{\sigma} A_{c'} \left( \frac{\sigma}{\sigma-1} P_{I}' \right)^{1-\sigma} \) are the respective market demand terms for the foreign country.\textsuperscript{35}

The interaction between CES preferences and fixed costs of exporting gives rise to a selection mechanism whereby only the most productive firms\textsuperscript{36} are able to cover \( f_{X} \) without incurring losses and successfully break into export markets. In the absence of fixed costs, either all or no firms would export. Selection into exporting therefore implies that only firms for which \( \pi'_{c}(\phi) \geq 0 \) become exporters. Rearranging (3.25) we obtain \( \phi_{c}^{X^{*}} \), which represents the minimum productivity required for a firm to outgrow the boundaries of

\textsuperscript{34}The domestic component of the exporter’s problem is identical to the non-exporter’s problem.

\textsuperscript{35}As the trade partners are not modelled to be symmetric, aggregate variables are not equalised across countries.

\textsuperscript{36}As the firms that brake into export markets are more productive compared to the firms with only domestic activities it follows that

\[ \phi_{c}^{X^{*}} \geq \phi_{c}^{*} \iff \frac{\phi_{c}^{X^{*}}}{\phi_{c}^{*}} \left( \frac{\tau}{P_{I}'} \right)^{a-1} \geq \frac{f_{D}}{P_{I}'} \left( \frac{P_{I}'}{P_{I}'} \right)^{-(a-1)} \]
the domestic market.\footnote{For each country \( c = \{h, f\} \) there is a pair of cutoffs for surviving on the domestic and the foreign markets.}

\[
\phi_{c}^{X} = \left( P_{c}^e X_{c} B_{c}^{-1} \right)^{\frac{1}{\sigma - 1}} \left( \frac{P_{c}^e}{P_{c}^x} \right)
\] (3.26)

### 3.2.3.3 Optimal input demand

Firm-level demand for the composite intermediate good is given by:\footnote{Using the \textit{Shepherd's Lemma} on the cost minimisation problem.}

\[
m_{c}(\phi) = f_{E} + A_{c} \left( \frac{\sigma}{\sigma - 1} P_{c}^y \right) \phi^{\sigma - 1} + f_{D} + \int_{I \left( 1 - A_{c} (\tau - \frac{\sigma}{\sigma - 1} P_{c}^y) \phi^{\sigma - 1} + f_{X} \right) I \int_{I \left( 1 - A_{c} (\tau - \frac{\sigma}{\sigma - 1} P_{c}^y) \phi^{\sigma - 1} + f_{X} \right)}} \]

\[
\text{intermediate requirement to serve the domestic market}
\]

\[
\text{additional intermediate requirement to serve the export market}
\]

where \( I \) is an indicator variable (\( I = \{0, 1\} \)) that takes up the value one if the firm exports. Demand for the domestic and the foreign intermediate goods respectively is given by:

\[
I_{c}^{e}(\phi) = \alpha_{c} \frac{P_{c}^e}{P_{c}^y} m_{c}(\phi)
\] (3.28)

\[
I_{c}^{f}(\phi) = (1 - \alpha_{c}) \frac{P_{c}^f}{\pi P_{c}^y} m_{c}(\phi)
\] (3.29)

### 3.3 Open economy equilibrium

The model features free entry. Free entry implies that in equilibrium, the measure of expected ex-ante profits (inclusive of the entry cost) must be equal to zero, i.e. the net value of entry is zero.

\[
\bar{v} = \int_{\phi_{c}^{\star}} \pi(\phi) \mu(\phi) d\phi + \int_{\phi_{c}^{\star}} \pi(\phi) \mu^{X}(\phi) d\phi
\] (3.30)
\[ v \text{ is the average value of firms conditional on successful entry, } \]

\[ \mu(\phi) \text{ is the conditional distribution of firm productivity on } [\phi_c^*, \infty) \]

\[ \mu^X(\phi) \text{ is the conditional distribution of firm productivity on } [\phi^X_c^*, \infty). \]

\[ [1 - G(\phi^*_c)]\left[ B_c(\hat{\phi}_c)^{a-1} - P_f f_D \right] \]

\[ + [1 - G(\phi^*_X)]\left[ B_c \left( \frac{P_I^c}{P_I} \right)^{1-a} (\hat{\phi}_c^X)^{a-1} - P_f^c f_X \right] = P_f^c \delta f_E \]

\[ \text{(3.31)} \]

The zero cutoff profit conditions (3.21) and (3.26), the free entry condition (3.31) and the respective relationships for the other country provide six equations involving \( \phi^*_c, \phi^*_X, B_c, \) where \( c = \{h, f\} \). Combining these equations along with the assumption of Pareto distributed productivity, we obtain for each country the equilibrium expressions \( B_c \)

\[ B_c = f_D P_I^c \left[ \delta f_E \Theta \left( \frac{1 - \tau^{-x} \left( \frac{P_c}{P_I} \right)^{-x} \left( \frac{f_D}{f_X} \right)^{\theta}}{1 - \tau^{-2x} \left( \frac{f_D}{f_X} \right)^{2\theta}} \right) \right]^{\frac{a-1}{\Delta}} \]

\[ \text{(3.32)} \]

\[ 39 \] \( v \) is the ex ante probability of survival on the domestic market, or equivalently the fraction of entrants that remain active.

\[ 40 \] \( \mu(\phi) \) and \( \mu^X(\phi) \) are defined in A.1.

\[ 41 \] In Appendices A.1-A.10, the equilibrium expressions are derived analytically.
where for expositional simplicity define $\Theta \equiv \frac{\kappa - \sigma + 1}{\sigma - 1}$; the domestic and export market cutoffs;

$$\Phi^c = \delta f_E \Theta \left( \frac{1 - \tau^{-\kappa} \left( \frac{P_I^c}{P_I} \right)^{\frac{\sigma}{1-\tau}} \left( \frac{f_D}{f_X} \right)^{\Theta}}{1 - \tau^{-2\kappa} \left( \frac{f_D}{f_X} \right)^{2\Theta}} \right)^{-\frac{1}{\kappa}} \tag{3.33}$$

$$\Phi^c_X = \tau \left( \frac{P_I^c}{P_I} \right)^{\frac{\sigma}{1-\tau}} \left( \frac{f_X}{f_D} \right)^{\frac{1}{1-\tau}} \delta f_E \Theta \left( \frac{1 - \tau^{-\kappa} \left( \frac{P_I^c}{P_I} \right)^{\frac{\sigma}{1-\tau}} \left( \frac{f_D}{f_X} \right)^{\Theta}}{1 - \tau^{-2\kappa} \left( \frac{f_D}{f_X} \right)^{2\Theta}} \right)^{-\frac{1}{\kappa}} \tag{3.34}$$

the number of firms

$$N^c = \frac{(1-\mu)}{\sigma \delta f_D} \left( \frac{w_c L^c}{L^c} \right) \left( 1 - \tau^{-\kappa} \left( \frac{P_I^c}{P_I} \right)^{\frac{\sigma}{1-\tau}} \left( \frac{f_D}{f_X} \right)^{\Theta} \right) \left( 1 - \tau^{-\kappa} \left( \frac{P_I^c}{P_I} \right)^{\frac{\sigma}{1-\tau}} \left( \frac{f_D}{f_X} \right)^{\Theta} \right)^{-\frac{1}{\kappa}} \left( 1 - \tau^{-\kappa} \left( \frac{P_I^c}{P_I} \right)^{\frac{\sigma}{1-\tau}} \left( \frac{f_D}{f_X} \right)^{\Theta} \right) \left( 1 - \tau^{-\kappa} \left( \frac{P_I^c}{P_I} \right)^{\frac{\sigma}{1-\tau}} \left( \frac{f_D}{f_X} \right)^{\Theta} \right)^{\frac{1}{\kappa}} \left( 1 - \tau^{-\kappa} \left( \frac{P_I^c}{P_I} \right)^{\frac{\sigma}{1-\tau}} \left( \frac{f_D}{f_X} \right)^{\Theta} \right)^{\frac{1}{\kappa}} \tag{3.35}$$

and the price of one unit of the manufacturing composite.

$$P^c = \left( \frac{\sigma f_D}{(1-\mu) w_c L^c} \right)^{\frac{1}{\kappa}} \frac{\sigma}{\sigma - 1} \Phi^c_X \tag{3.36}$$

### 3.4 How does a devaluation affect the economy?

Remember that the real exchange rate is modelled as the relative real wage $R = \frac{w_c}{w_c}$. A devaluation is therefore defined as an increase in $R$ and is tantamount to a fall in the relative productivity in the homogeneous sector, leading all else equal to a fall in the relative domestic wage. In the following sections, for expositional simplicity the foreign country wage is normalised
to unity. Hence, $R = \frac{1}{w_c}$ and a devaluation is equivalent to a fall in the domestic labour costs.

A devaluation renders domestically produced intermediates cheaper, enhancing the cost-competitiveness of final goods producers using $I_c$. In an interconnected world, like the one described here, where final goods producers have access to international markets of intermediates and final goods production technology is characterised by dependency on imported intermediates, several effects come to play. As domestically produced intermediates are used as inputs by final goods producers both at home and abroad, manufacturers in the devaluing country (Home) are not the only ones to enjoy cost-competitiveness gains. The trade partner's dependency on the use of Home's intermediates gives rise to favourable cost effects operating via a 'forward linkages' channel. Following a devaluation at Home, lower domestic wages spill-over to the foreign country through lower costs for intermediates. These effects go against the traditional 'terms of trade' effects and therefore the impact of a devaluation on the economy is ambiguous and depends on the relative intensity of the final production process in the domestic versus the imported intermediate inputs in both countries.

In the remaining sections, I study the impact of a devaluation at Home on the domestic economy by investigating the reaction of the intensive margin of exporting, i.e. the export sales of incumbent exporters $r^c_c(\phi)$, the adjustments along the extensive margin of exporting, i.e. the reaction of the export productivity cutoff $\phi^{X*}_c$ as well as the impact of a devaluation on aggregate exports and welfare.
3.4.1 Devaluation and the relative cost-competitiveness of final goods producers

The relative cost-competitiveness is defined as the relative cost of one unit of the composite factor of production at Home and abroad.

\[
P^c_I = \left( \frac{R \phi^c_I}{R \phi^c_I'} \right)^{1-\alpha_c-\alpha_{c'}} \tau^{\alpha_c-\alpha_{c'}} \tag{3.37}
\]

The impact of a devaluation (a rise in \( R \)) on the relative cost-competitiveness of the Home country \((P^c_I/P^c_I')\) is studied through the sign and magnitude of the following elasticity.

\[
\varepsilon_{P^c_I/P^c_I'} = \frac{\partial P^c_I/P^c_I'}{\partial R} = \frac{R}{P^c_I/P^c_I'} = 1 - \alpha_c - \alpha_{c'} \tag{3.38}
\]

A negative sign \( \varepsilon_{P^c_I/P^c_I'} < 0 \) implies that a devaluation improves the Home’s relative cost-competitiveness, i.e. \( P^c_I/P^c_I' \) falls. This is the case whenever \( 1 - \alpha_c - \alpha_{c'} < 0 \) \( \Leftrightarrow \alpha_c > 1 - \alpha_{c'} \) i.e. when the Home country’s final production uses more intensively, compared to the Foreign country, the domestically produced intermediate whose (relative) price falls in a devaluation. Since domestic and foreign intermediates are combined in the final goods production process, both countries realise cost-competitiveness gains from a devaluation. Indeed, \( \varepsilon_{P^c_I/P^c_I'} = -\alpha_c < 0 \) and \( \varepsilon_{P^c_I'/P^c_I} = -(1 - \alpha_{c'}) \), but these gains accrue higher to the Home country since the fall in \( P^c_I \) following devaluation is greater than the respective fall in \( P^c_I' \) if \( \alpha_c > 1 - \alpha_{c'} \). On the contrary, whenever the domestically produced intermediate is used more intensively in Foreign’s final goods production process\(^42\) i.e. \( 1 - \alpha_c - \alpha_{c'} > 0 \) \( \Leftrightarrow \alpha_c < 1 - \alpha_{c'} \Leftrightarrow \alpha_{c'} < 1 - \alpha_c \), the sign of (3.38) is positive and a devaluation

\(^42\) An example is the Swedish steel industry, which specialises in the production of advanced steel grades and products. The majority of these products is absorbed by export markets instead of being used as an input to the domestic industry (Jernkontoret, website).
deteriorates Home’s relative cost-competitiveness.

The intensity of the final goods production process at Home in the domestically produced intermediate (relative to its trade partner) will determine whether a devaluation at Home enhances its cost-competitiveness vis à vis its trade partners. When not accounting for dependency on imported intermediates i.e. assuming that final goods producers in each country use only domestically produced intermediates \(\alpha_c = \alpha_{c'} = 1\), the model ‘collapses’ to the reference model where the only factor of production is labour. In this case, \(\epsilon_{P_cI/P_{c'}I|R} = -1\) and devaluations always enhance Home’s relative cost-competitiveness in line with the traditional mechanisms. Taking into account intermediates trade and in particular, intermediate import dependence, moderates the pro-competitiveness gains arising to the devaluing country and can in fact even overturn them. Indeed, if both/either \(\alpha_c > 0\) and/or \(\alpha_{c'} > 0\) we have that \(|\epsilon_{P_cI/P_{c'}I|R}| < 1\).

### 3.4.2 How do devaluations affect firms’ export revenues?

The reaction of the intensive margin of trade, i.e. the revenues earned on the export market by incumbent exporters is examined through the sign and
magnitude of the following elasticity.\(^{43}\)

\[
\varepsilon_{r^c(\phi)|R} = \left[ -\sigma \left( \frac{P^r_c}{P^r_I} \right) \frac{1}{1 - \chi^{-\kappa} \left( \frac{P^r_c}{P^r_I} \right)^{\frac{\kappa}{\sigma}} \left( \frac{D}{X} \right)^{\Theta}} \right] + \alpha_c \quad (3.39)
\]

**Proposition 1.** The elasticity of firm-level export revenues with respect to the real exchange rate \( \varepsilon_{r^c(\phi)|R} \) is.\(^{44}\)

a. always of negative sign whenever \( \varepsilon_{P^r_c/P^r_I|R} > 0 \) and;

b. of ambiguous sign for \( \varepsilon_{P^r_c/P^r_I|R} < 0 \).

As discussed in the previous section, when domestically produced intermediates are used more intensively in the production of foreign final goods varieties, a real devaluation at Home grants greater cost competitiveness benefits to foreign manufacturers compared to domestic ones. Hence, all else equal, the prices of foreign final goods will fall more relative to the prices of domestically produced final goods. As consumers abroad substitute away from imports, final goods producers at Home witness their export revenues fall.

However, even when relative cost-competitiveness gains do occur for the devaluing country (Home) i.e. \( \varepsilon_{P^r_c/P^r_I|R} < 0 \), they do not necessarily translate

\(^{43}\)The requirement that \( \left\{ 1 - \chi^{-\kappa} \left( \frac{P^r_c}{P^r_I} \right)^{\frac{\kappa}{\sigma}} \left( \frac{D}{X} \right)^{\Theta} \right\} \geq 0 \) follows from the parameter restrictions to guarantee non-negative equilibrium price indices and number of firms. See discussion in Section A.10 in the Appendix.

\(^{44}\)Proof in Section P.1.
into higher export revenues for incumbent exporters. Classic terms of trade
effects may or may not prevail over ‘forward linkages effects’ depending
_inter alia_ on (i) the devaluing country’s relative intermediate import depend-
ence i.e. \((1 - \alpha_c) / (1 - \alpha_c')\), (ii) consumer demand elasticity \((\sigma)\) and (iii)
the degree of integration between the economies (i.e. the value of \(\tau\), where
as \(\tau \to 1\) the more integrated the economies). For certain combinations of
parameter values and the level of the real exchange rate, despite any rela-
tive cost-competitiveness gains accruing to the devaluing country, exporters’
revenues may indeed fall (see discussion in Appendix P.1).

In the absence of intermediates trade (i.e. the benchmark case, \(\alpha_c = \alpha_c' = 1\)) the ‘forward linkages’ channel is muted and therefore export revenues
always increase in response to a devaluation.

\[
\varepsilon r_c'(\phi)|R, \alpha_c=\alpha_c'=1 = \frac{\sigma - 1 + \tau^\kappa \left( \frac{P_f}{P_f'} \right)^\kappa (fD/fX) ^\Theta}{1 - \tau^\kappa \left( \frac{P_f}{P_f'} \right)^\kappa (fD/fX) ^\Theta} > 0 \tag{3.40}
\]

In Appendix P.1, I show that for standard parameter values even in the case
where revenues react positively following a devaluation \((\varepsilon r_c'(\phi)|R > 0)\), the
magnitude of this reaction attenuates as the importance of trade in interme-
diates increases (i.e. the greater the value of the expression \(1 - \alpha_c + 1 - \alpha_c'\)).
The outcome of this exercise is illustrated in Figure 3.1.45

45 Figure 3.1, suggests that \(\varepsilon r_c'(\phi)|R\) decreases with the level of \(R\) i.e. devaluations occurring
at a higher level of the real exchange rate are less attractive, exacerbating losses of export
revenues and dampening any gains. This is consistent with real models where the magnitude
of the effect depends on the level at which devaluations occur.
3.4.3 How does a devaluation affect the decision to export?

The response of the export cutoff to a real devaluation is summarized by the following elasticity:\(^{(46)}\)

$$
\varepsilon_{\psi^{X^*}_{c|F}} = \frac{\alpha}{\sigma - 1} \left( \frac{1}{1 - \tau} \right)^{\frac{\sigma - 1}{\sigma}} \left( \frac{P_{cF}}{P_{cF}^*} \right)^{\frac{\sigma - 1}{\sigma}} \left( \frac{I_{cS}}{I_{cS}^*} \right)^{\frac{\sigma - 1}{\sigma}}
$$

\(> 0\) under parameter restrictions

**Proposition 2.** The elasticity of the export productivity cutoff \(\psi_{c}^{X^*}\) with respect to the real exchange rate \(\varepsilon_{\psi^{X^*}_{c|F}}\) is:\(^{(47)}\)

- *Always positive sign whenever* \(1 - \alpha_c - \alpha_{c'} > 0\) i.e. \(\psi_{c}^{X^*}\) increases with \(F\). A devaluation reinforces selection into exporting driving the least

---

\(^{(46)}\) Exchange rate movements cause the domestic and export cutoffs to move to opposite directions as a result of the free entry condition.

\(^{(47)}\) See proof in Section P.2 of the Appendix.
productive among the incumbent exporters out of the export markets.

b. Always of negative sign whenever \( 1 - \alpha_c - \alpha_c' < 0 \) i.e. \( \phi^X_c \) decreases with \( R \). A devaluation then relaxes the minimum productivity required to break into the export markets thus allowing less productive firms to start exporting.

In the benchmark case, featuring no trade in intermediates, devaluations always induce positive adjustments along the extensive margin of trade.

\[
\varepsilon_{\phi^X_c|R,\alpha_c=\alpha_c'=1} = - \left( \frac{\alpha}{\sigma - 1} \right) \left( \frac{1}{1 - \tau^{-\kappa} \left( \frac{P^I_c}{P^I_c'} \right)^{\frac{\kappa}{\sigma - 1}} \left( \frac{f_D}{f_X} \right)^{\Theta}} \right) < 0 \quad (3.42)
\]

Comparing (3.41) and (3.42) it becomes apparent that the magnitude of positive adjustments along the extensive margin of exporting (when they occur) is smaller once trade in intermediate inputs is accounted for.

\[
|\varepsilon_{\phi^X_c|R,-1<1-\alpha_c-\alpha_c'<0}| \leq |\varepsilon_{\phi^X_c|R,\alpha_c=\alpha_c'=1}| \quad (3.43)
\]

Moreover, as it is shown in Figure 3.2, for standard values of the parameters, the magnitude of these positive adjustments along the extensive margin of exporting attenuates as the importance of trade in intermediates increases (i.e. the greater the value of \( 1 - \alpha_c + 1 - \alpha_c' \)).
3.4.4 How does a devaluation affect Aggregate Exports and Welfare per worker?

The aggregate exports of final goods from the Home country to its partner are given by:

$$EX^c = \frac{N^X}{\text{number of exporters}} \times \frac{r^c (\phi^X)}{\text{average export sales}}$$ (3.44)

One of the advantages of the Melitz [2003] framework is that aggregate variables can be written in terms of a weighted average of firm productivity. In this way the framework is equivalent to a model featuring a representative firm with productivity equal to this weighted average, which is endogenously determined by firm-level decisions.48 In (3.44), $\phi^X_c$ is the average

---

48 The aggregation process and the definition of the weighted productivity average are defined in Appendix A.1.
productivity of domestic producers that export to the foreign country and is defined as:

\[
\tilde{\phi}_c^X = \left( \int_{\tilde{\phi}_c^X}^{\infty} \phi^{\sigma-1} \frac{g(\phi)}{1 - G(\tilde{\phi}_c^X)} d\phi \right)^{\frac{1}{\sigma-1}}
\]  

where \(g(\phi)\), \(G(\phi)\) stand for the probability density function and the cumulative density function of the productivity distribution respectively. Hence the aggregate (final) exports are given by the expression:\(^{49}\)

\[
EX_c' = (1 - \mu) L^c \left( \frac{\tau^{-\kappa} \left( \frac{f_D}{f_X} \right)^\Theta}{1 - \tau^{-2\kappa} \left( \frac{f_D}{f_X} \right)^{2\Theta}} \right) \times 
\left[ \frac{1}{R} \left( 1 - \tau^{-\kappa} \left( \frac{P_c'}{P_I} \right)^{\frac{\mu}{\sigma-1}} \left( \frac{f_D}{f_X} \right)^\Theta \right) \left( \frac{P_c'}{P'_I} \right)^{-\frac{\mu}{\sigma-1}} - \tau^{-\kappa} \left( \frac{f_D}{f_X} \right)^\Theta \right] L^c'
\]

The reaction of Home’s aggregate exports to a devaluation is studied through the following elasticity:

\[
\eta_{EX_c'} = \frac{\partial EX_c'}{\partial \mu} \frac{\mu}{EX_c'}
\]  

**Proposition 3.** (i) For \(\eta_{P_c'/P_I'}|R > 0\) a devaluation induces a deterioration in the relative cost-competitiveness of Home’s final goods sector, causing aggregate exports to fall. (ii) Results are ambiguous in the case that \(\eta_{P_c'/P_I'}|R < 0\).

Not accounting for reliance on imported intermediates (i.e. for \(\alpha_c = \alpha_c' = 1\)), devaluations always induce an increase in aggregate (final) exports for the devaluing country. The analysis focuses on the response of exports of final goods rather than exports of intermediates or exports in general. The intermediates sector is assumed to operate in perfect competition and therefore as opposed to the final goods sector there are no rents. The final goods

\(^{49}\) Where the assumption that \(w_{c,c'} = 1\) is already in place.
sector on the other hand is of interest because there are rents. In this framework, it is only the final goods sector that is relevant for consumer welfare. Moreover, the final sector is relevant for moving up the value chain.\textsuperscript{50}

The impact of devaluations on welfare per worker is studied by looking at the respective elasticity:

\[ \varepsilon_{W_c|R} = \frac{\partial W_c}{\partial R} \frac{R}{W_c} \]  

(3.48)

**Proposition 4.** (i) For \( \varepsilon_{P_I/P_I'}|R > 0 \) a devaluation induces a welfare loss for the devaluing country. (ii) Results are ambiguous in the case that \( \varepsilon_{P_I/P_I'}|R < 0 \).

\textsuperscript{51}

### 3.4.5 Devaluations and trade liberalisation

The declining importance of distance and the progressive fall of barriers to trade are further tightening the interconnectedness of the global economy. In this section, I examine whether the impact of devaluations on firm-level export decisions and firm-level export performance depends on the degree of integration between the economies.

\[ -\frac{\partial^2 P_I'/P_{I'}'}{\partial R \partial \tau} = -(1 - \alpha_{c'} - \alpha_e)(\alpha_{c'} - \alpha_e) \frac{P_I'/P_{I'}'}{R} \tau^{\alpha_{c'} - \alpha_e - 1} \]  

(3.49)

The expression in (3.49) implies that as the trade partners’ economies become more integrated (i.e. as the barriers to trade subside and \( \tau \) falls) the impact of a devaluation on the devaluing country’s cost-competitiveness relative to its trade partner depends \textit{inter alia} on (i) the relative intensity of the final production process in the use of the domestically produced intermedi-

\textsuperscript{50}I study the response of intermediate exports to devaluations in Section P.5 in the Appendix. Note that the response of exports of intermediates following a devaluation is also of ambiguous sign.

\textsuperscript{51}See proof in section P.4 of the Appendix.
ate, i.e. the sign of the expression $1 - \alpha_c' - \alpha_c$ and (ii) Home's dependency on imported intermediates relative to its trade partner i.e. the sign of the expression $\alpha_c - \alpha_c'$. The direction of these effects as it is reflected on the sign of (3.49) is summarised in Table 3.1.

<table>
<thead>
<tr>
<th>$1 - \alpha_c' &lt; \alpha_c$</th>
<th>$1 - \alpha_c' &gt; \alpha_c$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha_c &gt; \alpha_c'$</td>
<td>$&lt; 0$</td>
</tr>
<tr>
<td>$\alpha_c &lt; \alpha_c'$</td>
<td>$&gt; 0$</td>
</tr>
</tbody>
</table>

When the domestically produced intermediate is used more intensively in the final goods production process at Home ($1 - \alpha_c' < \alpha_c$) and Home is less dependent on imported intermediates ($\alpha_c > \alpha_c'$), then as the integration between the trade partners advances, devaluations become more effective. Trade liberalisation further intensifies the relative cost competitiveness gains accruing to the devaluing economy. Likewise, if the domestically produced intermediate is used more intensively in the final goods production process abroad ($1 - \alpha_c' > \alpha_c$) and Home is more dependent on imported intermediates ($\alpha_c < \alpha_c'$) trade liberalisation renders devaluations more attractive as it dampens the loss of relative cost competitiveness accruing to the devaluing country. In the remaining cases however, trade integration limits the effectiveness of trade liberalisation as it contains any relative cost competitiveness gains and exacerbates the losses.

### 3.5 Concluding remarks

Trying to explain the lack of sensitivity of trade flows to exchange rate movements, the international trade literature has focused on different aspects of
I contribute to this literature by bringing attention to a rather intuitive mechanism, \textit{intermediate import dependence}. The main prediction of the model is that a country's relative use of domestically produced intermediates (\textit{with respect to its trade partners}), arises as the key determinant of the final goods producers' export status and export performance. In this context, favourable exchange-rate movements, or in general movements in relative prices, will induce smaller cost-competitiveness gains and contain any positive adjustments along both the extensive and intensive margins of trade, compared to the benchmark setting where we don't account for trade in intermediates.

What is more, the model provides clear-cut conditions for which devaluations in fact undermine the relative cost-competitiveness of the devaluing country, leading to a loss of export revenue and a negative adjustment along the extensive margin of trade.

For expositional purposes the model is hosted in a two-country, single industry world, where each country is a monopolist of the intermediate it produces. As a result, labour cost developments in either country affect the international price of the domestically produced intermediate, reinforcing the strength of the proposed mechanism.

In the real world, which features a more complex network of production and trade relationships, the effects discussed here are likely to be nuanced. The strength of the mechanism, will vary across industries depending on the country's specialisation and position in the global value chain, how big a 'player' the country is in the production of intermediates and the degree
of integration and interdependence between the devaluing country and its trade partners. In particular, the case where the devaluing country ends up being worse-off vis à vis its trade partners, is less likely to arise in a multi-country, multi-industry world, where each country specialises in the production of a continuum of intermediate inputs and import dependence is determined endogenously at the firm-level.

Despite its limitations, the model communicates a relevant message. The world economies have grown to be tightly intertwined. As a result, domestic cost developments spill over to other economies via the fragmented production network. This channel is often overlooked by policy makers. The proposed model illustrates the challenges faced by policy makers (and the literature) in unwinding the competing mechanisms that come to play and curb the stimulating effect of devaluations on export performance.

In addition, the model delivers clear-cut conditions that can serve as testable predictions in assessing the effects of devaluations.
Acknowledgments

I am grateful to my supervisors Rikard Forslid and Anders Akerman for their guidance. I am also thankful to Stelios Arvanitis, Teodora Borota Milicevic, Thomas Chaney, Gianmarco Ottaviano, Frank Portier and Yoichi Sugita and for their time and feedback and to the participants of the 15th Nordic International Trade Seminar, the CESifo-Delphi Conference on Current Account Adjustments and the 14th Annual GEP Postgraduate Conference for their useful comments. Any mistakes and unaddressed issues are my responsibility. Financial support from the Jan Wallanders & Tom Hedelius Stiftelse is gratefully acknowledged.
Appendix

Proofs

P.1 Proof of Proposition 1

Proof.

\[
\varepsilon_{r'c'}(\phi) > 0 \iff \frac{1 - \alpha_{c'}}{\alpha_c} < \left(1 - \frac{1 - \tau^{-\kappa} \left(\frac{p_{k}'}{p_{k}}\right)^{\frac{\kappa}{\sigma}} \left(\frac{l_{k}}{f_{k}}\right)^{\theta}}{1 - \tau^{-\kappa} \left(\frac{p_{k}'}{p_{k}}\right)^{\frac{\kappa}{\sigma}} \left(\frac{l_{k}}{f_{k}}\right)^{\theta}}\right) < 1
\]

\(P.1\)

(i) Whenever \(\varepsilon_{p} p_{k}' | R > 0\), i.e. \(1 < \frac{1 - \alpha_{c'}}{\alpha_c}\), the above condition never holds, hence the sign of this elasticity is clearly negative. A devaluation induces the deterioration of Home's relative cost-competitiveness which in turn, takes its toll on the export sales of incumbent exporters who witness their export revenues fall.

(ii) If however, \(\varepsilon_{p} p_{k}' | R < 0\), i.e. \(1 > \frac{1 - \alpha_{c'}}{\alpha_c}\), then the sign of this elasticity can be either negative or positive. Interestingly, even when devaluations induce relative cost-competitiveness gains for domestic final goods producers, these do not necessarily translate into higher export revenues for incumbent exporters. For certain combinations of the parameters and the level of the real exchange rate, despite the relative cost-competitiveness gains accruing to the devaluing country, exporters' revenues may indeed fall. Note that, in the absence of trade in intermediates (i.e. the benchmark case, \(\alpha_{c} = \alpha_{c'} = 1\)):

\[
\varepsilon_{r'c'}(\phi) | R = \left(\frac{\sigma - 1 + \tau^{-\kappa} \left(\frac{p_{k}'}{p_{k}}\right)^{\frac{\kappa}{\sigma}} \left(\frac{l_{k}}{f_{k}}\right)^{\theta}}{1 - \tau^{-\kappa} \left(\frac{p_{k}'}{p_{k}}\right)^{\frac{\kappa}{\sigma}} \left(\frac{l_{k}}{f_{k}}\right)^{\theta}}\right) > 0 \quad (P.2)
\]
Competitive effects of devaluations always prevail and export revenues increase. Moreover it can be shown that for quite standard parameter values even when revenues react positively following a devaluation, the magnitude of this reaction attenuates as the importance of trade in intermediates increases.

I want to compare:

\[ \epsilon_{rc'}(\phi) [\mathcal{R}]_{1-a_c-a_c'=0} = \frac{(\sigma - 1 + \tau^{-\kappa} \left( \frac{\mathcal{R}}{\mathcal{Q}_{c}} \right)^{-\frac{\sigma}{\sigma - 1}} \left( \frac{\mathcal{F}}{\mathcal{X}} \right)_{\phi}}{1 - \tau^{-\kappa} \left( \frac{\mathcal{R}}{\mathcal{Q}_{c}} \right)^{-\frac{\sigma}{\sigma - 1}} \left( \frac{\mathcal{F}}{\mathcal{X}} \right)_{\phi}} \]  

(P.3)

\[ -\sigma (1 - \alpha_c - \alpha_{c'}) \left( \frac{1}{1 - \tau^{-\kappa} \left( \frac{\mathcal{R}}{\mathcal{Q}_{c}} \right)^{1-a_c-a_{c'}} \left( \frac{\mathcal{F}}{\mathcal{X}} \right)_{\phi}^{\alpha_{c'}-\alpha_c}} \right) + \alpha_c \]  

(P.4)

If (P.1) holds:

\[ \frac{1 - \alpha_{c'}}{\alpha_c} < \left( 1 - \frac{1 - \tau^{-\kappa} \left( \frac{\mathcal{F}}{\mathcal{X}} \right)^{\frac{\sigma}{\sigma - 1}} \left( \frac{\mathcal{F}}{\mathcal{X}} \right)_{\phi}}{\sigma} \right) < 1 \]  

(P.5)

A general result cannot be established.

However \[ \epsilon_{rc'}(\phi) [\mathcal{R}]_{1-a_c-a_c'=0} = -1 \]  

\[ \epsilon_{rc'}(\phi) [\mathcal{R}]_{1-a_c-a_{c'} < 0} \text{ holds for} \]
\[
\begin{align*}
&\left(\frac{\sigma - 1 + \tau^{-\kappa} \left( \mathcal{R} \frac{\psi'_{c^*}}{\psi'_{c}} \right)^{-\frac{\mu c}{\mu}} \left( \frac{f_D}{f_X} \right)^{\Theta}}{1 - \tau^{-\kappa} \left( \mathcal{R} \frac{\psi'_{c^*}}{\psi'_{c}} \right)^{-\frac{\mu c}{\mu}} \left( \frac{f_D}{f_X} \right)^{\Theta}} \right) > \\
&\leq 0 \text{ under (P.1)}
\end{align*}
\]

\[
\begin{align*}
\sigma (1 - \alpha_{c,c'} - \alpha_c) & \left( \frac{\sigma - 1 + \tau^{-\kappa} \left( \mathcal{R} \frac{\psi'_{c^*}}{\psi'_{c}} \right)^{-\frac{\mu c}{\mu}} \left( \frac{f_D}{f_X} \right)^{\Theta}}{1 - \tau^{-\kappa} \left( \mathcal{R} \frac{\psi'_{c^*}}{\psi'_{c}} \right)^{-\frac{\mu c}{\mu}} \left( \frac{f_D}{f_X} \right)^{\Theta}} \right) \\
&\leq 0 \text{ under (P.1)}
\end{align*}
\]

\[\text{P.6}\]

**P.2 Proof of Proposition 2**

**Proof.** (i), (ii) For the set of parameters compatible with the necessary restrictions it is clear that whenever \( \epsilon_{P^*_c/P^*_c | R} > 0 \) then \( \epsilon_{\phi^* X^* | R} > 0 \) (and \( \epsilon_{\phi^*_c | R} < 0 \)), while for \( \epsilon_{P^*_c/P^*_c | R} < 0 \) we will have \( \epsilon_{\phi^* X^* | R} < 0 \) (and \( \epsilon_{\phi^*_c | R} > 0 \)). Note that for \( \alpha_c = \alpha_{c,c'} = 1 \) we have:

\[
\epsilon_{\phi^* X^* | R} = - \left( \frac{\sigma}{\sigma - 1} \right) \left( \frac{1}{1 - \tau^{-\kappa} \left( \mathcal{R} \frac{P^*_c}{P^*_c} \right)^{-\frac{\mu c}{\mu}} \left( \frac{f_D}{f_X} \right)^{\Theta}} \right) < 0 \quad \text{ (P.7)}
\]

In the benchmark case, featuring no trade in intermediates, devaluations always induce positive adjustments along the extensive margin of trade. Moreover, it can be shown that for standard calibrated values of the parameters even when positive adjustments along the extensive margin of trade occur, the magnitude of these adjustments is smaller once trade in intermediate inputs is accounted for.
We need to show that:

\[ |\epsilon_{\phi X}^c|_{|R|1=\alpha_c=\alpha'_c} > |\epsilon_{\phi X}^c|_{-1<\alpha_c-\alpha'_c<0} \] (P.8)

which is true for:

\[ \left( 1 - \tau^\kappa \left( \frac{P}{P_f} \right)^{\frac{\kappa}{2}} \left( \frac{f_D}{f_X} \right) \Theta + \frac{\kappa \sigma}{\sigma - 1} \left( \epsilon_{P/P_f}^c \right) (1 - \tau^{-2\kappa}) \left( \frac{f_D}{f_X} \right)^{2\Theta} \right) \left( 1 - \tau^\kappa \right) \left( \frac{P}{P_f} \right)^{\frac{\kappa}{2}} \left( \frac{f_D}{f_X} \right) \Theta > |1 - \alpha_c - \alpha'_c| \] (P.9)

A general result cannot be established. However for standard parameter values this condition holds. Results are summarised in the following graph.

P.3 Proof of Proposition 3

Proof.

\[ \epsilon_{EX}^c|_{|R|} = \frac{\partial EX^c}{\partial R} \frac{R}{EX^c} \]

\[ = \frac{1 - \tau^{-\kappa} \left( \frac{P}{P_f} \right)^{\frac{\kappa}{2}} \left( \frac{f_D}{f_X} \right) \Theta + \frac{\kappa \sigma}{\sigma - 1} \left( \epsilon_{P/P_f}^c \right) (1 - \tau^{-2\kappa}) \left( \frac{f_D}{f_X} \right)^{2\Theta} \left( \frac{P}{P_f} \right)^{\frac{\kappa}{2}} \left( \frac{f_D}{f_X} \right) \Theta}{1 - \tau^{-\kappa} \left( \frac{P}{P_f} \right)^{\frac{\kappa}{2}} \left( \frac{f_D}{f_X} \right) \Theta - \tau^{-\kappa} \left( \frac{P}{P_f} \right)^{\frac{\kappa}{2}} \left( \frac{f_D}{f_X} \right) \Theta \left( \frac{P}{P_f} \right)^{\frac{\kappa}{2}} \left( \frac{f_D}{f_X} \right) \Theta} \]

The sign of this expression, depends on the sign of:

\[ 1 - \tau^{-\kappa} \left( \frac{P}{P_f} \right)^{\frac{\kappa}{2}} \left( \frac{f_D}{f_X} \right) \Theta + \frac{\kappa \sigma}{\sigma - 1} \left( \epsilon_{P/P_f}^c \right) \left( 1 - \tau^{-2\kappa} \left( \frac{f_D}{f_X} \right)^{2\Theta} \right) \]

(P.10)

If \( \epsilon_{P/P_f}^c |_{|R|} > 0 \) then this expression is unambiguously positive and \( \epsilon_{EX}^c |_{|R|} < 0 \). When \( \epsilon_{P/P_f}^c |_{|R|} < 0 \) the sign of \( \epsilon_{EX}^c |_{|R|} \) is ambiguous. We will have that
\( \varepsilon_{EX_t}^c | R > 0 \) whenever

\[
\frac{1 - \tau^{-\kappa} \left( \frac{P_t}{P_t'} \right)^{\frac{\sigma}{\alpha - 1}} \left( \frac{f_D}{f_X} \right)^{\Theta}}{1 - \tau^{-2\kappa} \left( \frac{f_D}{f_X} \right)^{2\Theta}} \times \frac{\sigma - 1}{\kappa} < \frac{\left| \varepsilon_{P_t^c/PR_t'} | R \right|}{\left| 1 - \alpha_e - \alpha_e' \right|} \quad (P.12)
\]

In the absence of trade in intermediates, i.e. for \( \varepsilon_{P_t^c/PR_t'} | R = -1 \) the above condition, always holds since:

\[
1 - \tau^{-\kappa} \left( \frac{P_t}{P_t'} \right)^{\frac{\sigma}{\alpha - 1}} \left( \frac{f_D}{f_X} \right)^{\Theta} < 1 \\
1 - \tau^{-2\kappa} \left( \frac{f_D}{f_X} \right)^{2\Theta} < 1 \\
\]

\( (P.13) \)

We also need the following to hold:

\[
\frac{1 - \tau^{-\kappa} \left( \frac{P_t}{P_t'} \right)^{\frac{\alpha - 1}{\alpha}} \left( f_D \right)^{\Theta}}{1 - \tau^{-2\kappa} \left( \frac{f_D}{f_X} \right)^{2\Theta}} < 1 \iff 1 > \tau^{-\kappa} \left( \frac{P_t}{P_t'} \right)^{-\frac{\alpha - 1}{\alpha}} \left( f_D \right)^{\Theta} \quad (P.14)
\]

which is always true by our core parameter restrictions. Hence, for \( 1 - \alpha_e - \alpha_e' = -1 \) aggregate exports always react positively to devaluation as traditional mechanisms would suggest. ■
**P.4 Proof of Proposition 4**

Proof. The elasticity for welfare to the real exchange rate is given by:

\[
\varepsilon_{w_c|R} = \frac{\partial w_c}{\partial R} \frac{R}{w_c}
\]

\[
= -\sigma \left[ (1 - \alpha_c) + \frac{\chi^{-\kappa} \left( (R\Phi^c_i)^1 - \alpha_c \tau \alpha_c' - \alpha_c \right)^{\frac{\sigma}{\sigma - 1}} \left( \frac{\omega}{f_X} \right)^\Theta}{1 - \chi^{-\kappa} \left( (R\Phi^c_i)^1 - \alpha_c \tau \alpha_c' - \alpha_c \right)^{\frac{\sigma}{\sigma - 1}} \left( \frac{\omega}{f_X} \right)^\Theta} \right]
\]

(P.15)

The sign of \(\varepsilon_{w_c|R}\):

- If \(\varepsilon_{I/P^c_i/P^c_i'}|R| > 0\) then it is always the case that \(\varepsilon_{w_c|R} < 0\) hence devaluations induce a loss of welfare for the devaluing country.

- If \(\varepsilon_{I/P^c_i/P^c_i'}|R| < 0\) then in order to have welfare improving devaluations we would need:

\[
1 - \chi^{-\kappa} \left( \frac{P^c_i}{P^c_i'} \right)^{\frac{\sigma}{\sigma - 1}} \left( \frac{f_X}{\omega} \right)^\Theta \leq |\varepsilon_{I/P^c_i/P^c_i'}|R|
\]

(P.16)

Moreover

\[
\varepsilon_{w_c|R}|1 - \alpha_c - \alpha_c' = -1 = \frac{\sigma}{\sigma - 1} \frac{\chi^{-\kappa} \left( \frac{P^c_i}{P^c_i'} \right)^{\frac{\sigma}{\sigma - 1}} \left( \frac{f_X}{\omega} \right)^\Theta}{1 - \chi^{-\kappa} \left( \frac{P^c_i}{P^c_i'} \right)^{\frac{\sigma}{\sigma - 1}} \left( \frac{f_X}{\omega} \right)^\Theta} > 0
\]

(P.17)

Hence in the absence of trade in intermediates, devaluations are always welfare improving. □
P.5 Devaluation and exports of intermediates

Only developments in the final goods sector are relevant for welfare, hence the lion’s share of the analysis is dedicated to aggregate exports performed by final goods producers. It is however useful to see what happens to exports of intermediates as well since they also generate revenue for the economy. Foreign demand for the domestically produced intermediate input $I_c$ is given by:

$$I_c^e(\phi) = N_c' \left(1 - \alpha_c\right) \frac{P_I^c}{\tau_{P_I}} \left(\frac{\sigma}{\sigma - 1} P_I^c\right)^{-\sigma} \left(\frac{\sigma}{\sigma - 1} P_I^c\right)^{\sigma - 1} \left(\tilde{\phi}_c^e\right)^{\sigma - 1} + f_D + f_E \right) + \\
\left(1 - \alpha_c\right) \frac{P_I^c}{\tau_{P_I}} \left(\frac{\sigma}{\sigma - 1} P_I^c\right)^{-\sigma} \left(\tilde{\phi}_c^X\right)^{\sigma - 1} + f_X \right) N_c^X \tag{P.18}\right)$$

replacing for the equilibrium expressions for $N_c'$, $N_c^X$, $A_c$, $A_c$, $\tilde{\phi}_c^e$, $\tilde{\phi}_c^X$ we have:
\[ \frac{I_c}{\Delta} = \left( R - \tau^{-\kappa} \left( \frac{P_c}{P_i} \right)^{\frac{\alpha c}{\sigma - 1}} \left( \frac{f_D}{f_X} \right) \right) \Theta \left( 1 - \tau^{-\kappa} \left( \frac{P_c}{P_i} \right)^{\frac{2\mu}{\sigma - 1}} \left( \frac{f_D}{f_X} \right) \right) \left( \frac{f_c}{L^c} \right) \right) \]

\[ \times \left[ \left( \frac{\kappa}{\sigma - 1} \right)^{\frac{\alpha - 1}{\kappa}} + 1 \right] f_D + f_E \]

\[ + \tau^{-\kappa} \left( \frac{f_D}{f_X} \right) \Theta \left( 1 - \tau^{-\kappa} \left( \frac{P_c}{P_i} \right)^{\frac{2\mu}{\sigma - 1}} \left( \frac{f_D}{f_X} \right) \right) \left( \frac{P_c}{P_i} \right)^{\frac{\alpha c}{\sigma - 1}} \left( \frac{f_D}{f_X} \right) \theta L^c \]

\[ \times \left[ \kappa \left( \frac{\kappa}{\sigma - 1} \right)^{\frac{\alpha - 1}{\kappa}} + 1 \right] f_X \]

(P.19)

where

\[ \Delta \equiv (1 - \alpha_c) \left( \frac{1}{f_D} \right)^{\frac{1}{\Phi_i}} \left( \frac{1 - \mu}{\Phi_i} \right) \left( \frac{\kappa - 1}{\Phi_i} \right) \left( \frac{L^c}{f_X} \right) \left( \frac{1}{\Phi_i} \right)^{\frac{2\theta}{\kappa \sigma}} > 0 \]

(P.20)
The reaction of intermediate exports to a devaluation are summarised by:

\[
\frac{\partial I_c^e}{\partial R} \Delta = \left(1 + \frac{\sigma \kappa}{\sigma - 1} \tau^{-\kappa} \left(\frac{P_c^e}{P_{c'}^e}\right)^{\frac{\sigma - 1}{\sigma - 1}} \left(\frac{f_D}{f_{X}}\right)^{\Theta} \left(\frac{P_c^e}{P_{c'}^e}\right) \right) \times \left(A + \frac{\sigma \kappa}{\sigma - 1} \tau^{-\kappa} \left(\frac{P_c^e}{P_{c'}^e}\right)^{\frac{\sigma - 1}{\sigma - 1}} \left(\frac{f_D}{f_{X}}\right)^{\Theta} \left(\frac{P_c^e}{P_{c'}^e}\right) \right) \times \left(B + A \frac{\sigma \kappa}{\sigma - 1} \tau^{-\kappa} \left(\frac{P_c^e}{P_{c'}^e}\right)^{\frac{\sigma - 1}{\sigma - 1}} \left(\frac{f_D}{f_{X}}\right)^{\Theta} \left(\frac{P_c^e}{P_{c'}^e}\right) \right) \times \left[\kappa \left(\frac{\kappa - \sigma + 1}{\sigma - 1}\right)^{\frac{\sigma - 1}{\kappa}} + 1\right] f_X
\]

where (subject to the parameter restrictions discussed in Section A.10,

\[
A = 1 - \tau^{-\kappa} \left(\frac{P_c^e}{P_{c'}^e}\right)^{\frac{\sigma \kappa}{\sigma - 1}} \left(\frac{f_D}{f_{X}}\right)^{\Theta} > 0
\] (P.22)

Moreover,

\[
B = \left(1 - \tau^{-\kappa} \left(\frac{P_c^e}{P_{c'}^e}\right)^{\frac{\sigma \kappa}{\sigma - 1}} \left(\frac{f_D}{f_{X}}\right)^{\Theta}\right) > 0
\] (P.23)

The reaction of exports of intermediates therefore will also depend on the sign and magnitude of \(\varepsilon_{P_c^e/P_{c'}^e|R}\).
Special issues: discussing modelling assumptions

S.1 Accounting for labour in the production of final goods

In the baseline model, labour is only indirectly employed in the production of the final good. Intermediates are produced with local labour hence labour costs affect the cost of production in the final goods sector through the price of the intermediate inputs. This assumption can be deemed misleading and it is therefore relaxed in the current section where the production function takes the following form:

\[ Q_c = \bar{\eta}_c \phi L^c (X_c)^{1-\eta_c} \]  
\[ \bar{\eta}_c = \eta_c^{-\eta_c} (1 - \eta_c)^{-(1-\eta_c)} \], and

\[ X_c = \bar{\alpha}_c (I_c)^{\alpha_1 c} (I'_c)^{\alpha_2 c} \] 
\[ \bar{\alpha}_c = (1 - \eta_c) \alpha_{1c} \alpha_{2c} \]  and \( \alpha_{1c} + \alpha_{2c} = 1 - \eta \) The resulting unit cost faced by all final goods producers in the home country is now:

\[ \tilde{P}_c = (w_c)^\eta \left( \frac{w_c}{\phi_c} \right)^{\alpha_1} \left( \frac{w'_c}{\phi'_c} \right)^{\alpha_2} \]  

and the Home country’s relative cost competitiveness:

\[ \frac{\tilde{P}_c}{\tilde{P}_j} = \frac{(\phi'_j)^{\alpha_{1j} - \alpha_{1c}}}{(\phi'_j)^{\alpha_{1j} - \alpha_{1c}}} q^{\alpha_{2j} - \alpha_{2c}} \eta_{c}^{\alpha_{2j} - \alpha_{2c}} \]  

and the respective elasticity of Home’s relative cost competitiveness with
respect to the real exchange rate $R$ is:

$$\varepsilon p_{f}^{c} / p_{f}^{c'}|_{R} = \alpha_{c} \eta - \eta_{c} - \alpha_{c1}$$

(S.5)

Real devaluations are enhancing Home’s relative cost competitiveness whenever $\eta_{c} + \alpha_{c1} > \alpha_{c2}$, i.e. whenever the direct and indirect share of domestic labour embedded in the final goods production process of Home producers is higher than the respective (indirect) share of domestic labour in the final goods production process abroad. Clearly, directly accounting for labour attenuates the strength of the proposed mechanism which however remains present and conclusions are useful. The mechanism will be stronger for less labour intensive industries suggesting that the scope for gains associated with devaluations will be limited in less labour intensive industries.

S.2 Considering an alternative production function

Assume instead that the aggregation of the domestic and the imported intermediates has the CES form:

$$X_{c} = \left[ \frac{1}{\alpha_{c}} (I_{c})^{\eta} + (1 - \alpha_{c}) \frac{1}{\eta} (I_{c}^{*})^{\eta} \right]^{\eta^{-1}}$$

(S.6)

The cost of one unit of the composite production input is:

$$P_{c}^{c} \left[ \alpha_{c} \left( \frac{w_{c}}{\phi_{f}} \right)^{\frac{1}{\eta}} + (1 - \alpha_{c}) \left( \frac{w_{c}^{*}}{\phi_{f}^{*}} \right)^{\frac{1}{\eta}} \right]^{1 - \frac{1}{\eta}}$$

(S.7)

and the relative cost competitiveness of the Home country:

$$\frac{P_{c}}{P_{f}^{c'}} = \left[ \frac{\alpha_{c} \left( \frac{w_{c}}{\phi_{f}} \right)^{1 - \eta} + (1 - \alpha_{c}) \left( \frac{w_{c}^{*}}{\phi_{f}^{*}} \right)^{1 - \eta}}{\alpha_{c'} \left( \frac{w_{c'}}{\phi_{f}'} \right)^{1 - \eta} + (1 - \alpha_{c'}) \left( \frac{w_{c'}^{*}}{\phi_{f'}^{*}} \right)^{1 - \eta}} \right]^{1 - \frac{1}{\eta}}$$

(S.8)
The reaction of Home’s relative cost competitiveness to a devaluation depends on the sign of the expression \((1 - \alpha_c')(1 - \alpha_c)\tau^2(1-\eta) - \alpha_c\alpha_c'\). Devaluations enhance Home’s relative cost-competitiveness whenever:

\[
\frac{(1 - \alpha_c')}{\alpha_c'} \tau^2(1-\eta) < \frac{\alpha_c}{(1 - \alpha_c)}
\]

Foreign’s relative intensity in the domestic intermediate < Home’s relative intensity in the domestic intermediate.
Guide to main Results

A.1 Aggregation

Aggregate variables can be written in terms of a weighted average of firm productivity.\(^{52}\) As in the benchmark Melitz [2003] model, aggregate variables take the same values as in a model featuring a representative firm with productivity, equal to this weighted average, endogenously determined by firm decisions. \(\hat{\phi}_c\) is the average productivity of domestic producers that are active on the domestic market.

\[
\hat{\phi}_c = \left( \int \phi^{a-1} \mu (\phi) \, d\phi \right)^{\frac{1}{a-1}}
\]  

(A.1.1)

where \(\mu(\phi)\) is the conditional distribution of \(g(\phi)\) on \([\phi^*_c, \infty)\) where \(\phi^*_c\) is the survival productivity cutoff i.e. the lowest productivity level of producing firms.

\[
\mu(\phi) = \begin{cases} 
\frac{g(\phi)}{\left(1-G(\phi^*_c)\right)}, & \text{if } \phi \geq \phi^*_c, \\
0, & \text{otherwise.}
\end{cases}
\]  

(A.1.2)

In the same vein, \(\hat{\phi}_i^X\) is the average productivity of domestic producers that export to the foreign country (\(\hat{\phi}_i^X\)).

\[
\hat{\phi}_i^X = \left( \int \phi^{a-1} \mu^X (\phi) \, d\phi \right)^{\frac{1}{a-1}}
\]  

(A.1.3)

where \(\mu^X (\phi)\) is the conditional distribution of \(g(\phi)\) on \([\phi^*_c, \infty)\) where \(\phi^*_i^X\) is the export productivity cutoff i.e. the lowest productivity level of exporting firms.

\[
\mu^X (\phi) = \begin{cases} 
\frac{g(\phi)}{\left(1-G(\phi^*_c)\right)}, & \text{if } \phi \geq \phi^*_i^X, \\
0, & \text{otherwise.}
\end{cases}
\]  

(A.1.4)

\(^{52}\)In fact \(\hat{\phi}\) is a harmonic average of firm productivity \(\phi\), weighted by relative output shares \(q(\phi)/q(\hat{\phi})\).
\[ \tilde{\phi}_c \text{ and } \tilde{\phi}_c^X \text{ depend on the domestic and export productivity cutoffs } \phi_c^*, \phi_c^{X*} \text{ i.e. the minimum productivity level required for a firm to survive on the domestic market, or export to the foreign market respectively, without incurring any losses.} \]

The productivity averages \( \tilde{\phi}_c \), \( \tilde{\phi}_c^X \) can also be used to express the average profit and revenue levels across different groups of firms, hence:

\[
\begin{align*}
\bar{r}_c(\tilde{\phi}_c) &= \int r_c(\phi) \mu(\phi) d\phi \\
\bar{\pi}_c(\tilde{\phi}_c) &= \int \pi_c(\phi) \mu(\phi) d\phi
\end{align*}
\] (A.1.5) (A.1.6)

represent the average revenue and profit earned by domestic firms from sales in their own country,

\[
\begin{align*}
\tilde{r}_c(\tilde{\phi}_c^X) &= \int \tilde{r}_c(\phi) \mu^X(\phi) d\phi \\
\tilde{\pi}_c(\tilde{\phi}_c^X) &= \int \tilde{\pi}_c(\phi) \mu^X(\phi) d\phi
\end{align*}
\] (3.7) (3.8)

represent the average export revenue and profit to any given country across all domestic firms that export. The overall average, across all domestic firms, of combined revenue \( \bar{r} \) and profit \( \bar{\pi} \) earned from both domestic and export sales are given by

\[
\begin{align*}
\bar{r}_c &= r_c(\tilde{\phi}_c) + f_c^X r_c(\tilde{\phi}_c^X) \\
\bar{\pi}_c &= \pi_c(\tilde{\phi}_c) + f_c^X \pi_c(\tilde{\phi}_c^X) = \frac{r_c(\tilde{\phi}_c)}{\sigma} - w_c f_D + f_c^X \left( \frac{r_c(\tilde{\phi}_c^X)}{\sigma} - w_c^f f_X \right)
\end{align*}
\] (3.9) (3.10)

The overall average productivity prevailing on \( c \)'s market is a weighted average of the productivities of all the firms operating in \( c \), i.e. domestic producers as well as foreign exporters. The productivity of foreign exporters...
is adjusted for the output loss due to the variable trade cost \( \tau \) as well as the relative competitiveness of the final sector with respect to the other country, i.e. the ratio of the variable production costs. \( f_{in}^c \) and \( s_X^c \) are defined as the ex ante probability of survival on the domestic and export markets respectively.

\[
f_{in}^c = 1 - G(\phi_c^*)
\]

\[
s_X^c = \frac{1 - G(\phi_X^*)}{1 - G(\phi_c^*)}
\]

Moreover, \( f_{in}^c \) and \( s_X^c \) stand for the ex post fraction of entrants that survive on the domestic market and the ex post fraction of domestic firms that export respectively. Therefore, if \( N^e \) is the equilibrium mass of incumbent firms in country \( e \) then \( N_X^c = s_X^c N^e \), \( N^e \) is the mass of exporting firms and \( N_T^e = N^e + N_X^c = N^e + s_X^c N^{ed} \) represents the total mass of firms competing in the domestic market, both domestic and exporters as well as the total mass of varieties available to consumers in a country.

\[
\tilde{\phi}_T^e = \left( \frac{N^e}{N_T^e} \tilde{\phi}_e^{\sigma - 1} + \frac{N_X^c}{N_T^e} \left( \frac{P_T^{ed}}{P_T^e} \right)^{1 - \alpha} \left( \tilde{\phi}_X^{ed} \right)^{\sigma - 1} \right)^{\frac{1}{\sigma - 1}}
\]

\( \tilde{\phi}_T^e \) is the weighted productivity average of all firms (domestic and foreign) that compete on the domestic market. This productivity average fully summarises the effects of the distribution of productivity levels on the aggregate outcome.

The Manufacturing Price Index can be written as a function of \( \tilde{\phi}_T^e \):

\[
P^e = (N_T^e)^{1 - \sigma} \tilde{\phi}_T^e (\tilde{\phi}_T^e) = (N_T^e)^{1 - \sigma} \left( \frac{\sigma}{\sigma - 1} \frac{P_T^e}{\tilde{\phi}_T^e} \right)
\]
The composite consumption index in country $c$:

$$Q_c^T = (N_c^T)^{1/1} Q_c^T = (N_c^T)^{1/1} \left( A_c \left( \frac{\sigma}{\sigma - 1} \frac{P^c_c}{\tilde{\phi}_c^T} \right)^{-\sigma} \right) \quad (A.1.15)$$

### A.2 The Pareto distribution

The variable $\phi$ is assumed to follow a Pareto distribution with shape parameter $\kappa > \sigma - 1$. The support is $[\phi_{\min}, +\infty)$. The cumulative distribution function of a Pareto distribution is

$$G(\phi^*) = \begin{cases} 1 - \frac{\phi_{\min}}{(\phi^*)^{\kappa}}, & \text{if } \phi \geq \phi_{\min} \\ 0 & \text{otherwise.} \end{cases} \quad (A.2.1)$$

and the probability distribution function

$$g(\phi) = \begin{cases} \frac{\phi_{\min} \kappa^{\kappa + 1}}{(\phi^*)^{\kappa + 1}} & \text{if } \phi \geq \phi_{\min} \\ 0 & \text{otherwise.} \end{cases} \quad (A.2.2)$$

the expected value is given by

$$E(\phi) = \int_{\phi_{\min}}^{\infty} \phi g(\phi) d\phi = \begin{cases} \infty & \text{if } \kappa \leq 1 \\ \frac{\kappa}{\kappa - 1} \phi_{\min} & \text{if } \kappa > 1. \end{cases} \quad (A.2.3)$$

We normalise $\phi_{\min}$ to unity. Power functions of a Pareto distributed random variable also follow a Pareto distribution. Therefore,

$$\tilde{\phi}_c^{\sigma - 1} = \int_{\phi_c^*}^{\infty} \phi^{\sigma - 1} \mu(\phi) d\phi = \frac{1}{1 - G(\phi^{*})} \int_{\phi_c^*}^{\infty} \phi^{\sigma - 1} g(\phi) d\phi$$

$$= (\phi_c^*)^{\sigma - 1} \int_{\phi_c^*}^{\infty} \frac{\phi^*}{\phi^{\sigma - 1} \phi^{\sigma - 1}} d\phi = \frac{\kappa}{\kappa - \sigma + 1} \left( \phi_c^* \right)^{\sigma - 1} \quad (A.2.4)$$

and for the export cutoff we shall have that

$$\left( \tilde{\phi}_c^{*} \right)^{\sigma - 1} = \frac{\kappa}{\kappa - \sigma + 1} \left( \phi_c^{*} \right)^{\sigma - 1} \quad (A.2.5)$$
The average productivity of all firms active in the local economy

\[
\tilde{\phi}_c^T = \left( \frac{N^c}{N^T} \tilde{\phi}_c^{a-1} + \frac{N^c}{N^T} \left( \frac{P_c'}{P_I'} \right)^{1-\sigma} \left( \tilde{\phi}_c^X \right)^{a-1} \right)^{\frac{1}{1-\sigma}}
\]  
(A.2.6)

Moreover the average revenue realised on the domestic and export markets respectively:

\[
r_c(\tilde{\phi}_c) = \int r_c(\phi) \mu(\phi) d\phi
\]  
(A.2.7)

\[
r_c'(\tilde{\phi}_c^X) = \int r_c'(\phi) \mu(X(\phi)) d\phi
\]  
(A.2.8)

### A.3 Existence and uniqueness of equilibrium

\[
[1 - G(\phi_c^*]) \left[ B_c(\tilde{\phi}_c) \sigma - 1 - P_I f_D \right] + [1 - G(\phi_c^X)] \left[ B_c' \left( \frac{P_c'}{P_I'} \right)^{1-\sigma} \left( \tilde{\phi}_c^X \right)^{\sigma - 1} - P_I f_X \right] = P_I \delta f_E
\]

using the ZCP conditions the LHS becomes

\[
[1 - G(\phi_c^*]) \left[ B_c(\tilde{\phi}_c) \sigma - 1 - B_c(\phi_c^*) \sigma - 1 \right] + [1 - G(\phi_c^X)] \left[ B_c' \left( \frac{P_c'}{P_I'} \right)^{1-\sigma} \left( \tilde{\phi}_c^X \right)^{\sigma - 1} - B_c' \left( \frac{P_c'}{P_I'} \right)^{1-\sigma} \left( \phi_c^X \right)^{\sigma - 1} \right] = \]

\[
[1 - G(\phi_c^*]) B_c(\phi_c^*)^{a-1} - 1 + [1 - G(\phi_c^X)] B_c' \left( \frac{P_c'}{P_I'} \right)^{1-\sigma} \left( \phi_c^X \right)^{\sigma - 1} - 1] \]

\[
[1 - G(\phi_c^*]) B_c' \left( \frac{P_c'}{P_I'} \right)^{1-\sigma} \left( \phi_c^X \right)^{\sigma - 1} - 1] \]

Hence

\[
\iff f_D[1 - G(\phi_c^*)][\tilde{\phi}_c^*]^{a-1} - 1] + f_X [1 - G(\phi_c^X)][\tilde{\phi}_c^X]^{a-1} - 1] = \delta f_E
\]

(A.3.2)
Define
\[ k(\phi^*) = \left( \frac{\hat{\phi}(\phi^*)}{\phi^*} \right)^{\sigma - 1} - 1 \]  
(A.3.3)
\[ j(\phi^*) = [1 - G(\phi^*)]k(\phi^*) \]  
(A.3.4)

The FE condition becomes
\[ fDj(\phi^*_c) + fXj(\phi^*_X) = \delta f_E \]  
(A.3.5)

under the Pareto distribution assumption
\[ j(\phi^*) = \left( \frac{\phi_{\text{min}}}{\phi^*} \right)^{\kappa} \left[ \frac{\kappa}{\kappa - \sigma + 1} \left( \frac{\phi^*}{\phi_{\text{min}}} \right)^{\sigma - 1} - 1 \right] = \left( \frac{\phi_{\text{min}}}{\phi^*} \right)^{\kappa} \frac{\sigma - 1}{\kappa - \sigma + 1} \]  
(A.3.6)

\[ \lim_{\phi^* \to \infty} j(\phi^*) = 0 \]  
(A.3.7)

and
\[ \lim_{\phi^* \to 0} j(\phi^*) = \infty \]  
(A.3.8)

\[ \frac{\partial j(\phi^*)}{\partial \phi^*} = -\kappa(\phi_{\text{min}})^{\kappa} \frac{1}{\Theta(\phi^*)^{\kappa + 1}} < 0 \]  
(A.3.9)

Hence \( j(\phi^*) \) is monotonically decreasing from \( \infty \) to \( 0 \) on \((0, \infty)\). Moreover,
\[ \frac{\partial j(\phi^*)}{\partial \phi^*} \frac{\phi^*}{j(\phi^*)} = -\kappa < 0 \]  
(A.3.10)

which is bounded away from zero. It then follows from applying a simple fixed point theorem that there is a unique equilibrium cutoff level.

### A.4 Deriving (3.32)

Given the assumption of Pareto distributed productivity we can replace in (3.31) for
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Using the expression for $A.5$ Deriving the equilibrium cutoffs

Solving 

replacing for $\phi_c$ and $\phi^X_c$ from (3.21) and (3.26)

\[
\left(\frac{\sigma - 1}{\kappa - \sigma + 1}\right) \left[ B_c (\phi_c^*)^{\sigma-1} + B_c' \left( \frac{P_c^e}{P^e} \right)^{1-\sigma} (\phi^X_c)^{\sigma-1} \right] = \tilde{P}_T \delta f_E
\]  
(A.4.1)

and taking into account the ZCP conditions (3.21) and (3.26)

\[
\left(\frac{1}{\Theta}\right) \left[ (B_c) \frac{\phi}{\kappa} (f_D)^{-\Theta} + (B_c') \frac{\phi}{\kappa} \left( \frac{P_c^e}{P^e} \right)^{-\kappa} (f_X)^{-\Theta} \right] = (\tilde{P}_T)^{\frac{\phi}{\kappa}} \delta f_E
\]  
(A.4.2)

Solving (A.4.2) for $B_c$

\[
(B_c) \frac{\phi}{\kappa} = \left[ (P^e) \frac{\phi}{\kappa} \delta f_E \Theta - (B_c') \frac{\phi}{\kappa} \left( \frac{P_c^e}{P^e} \right)^{-\kappa} (f_X)^{-\Theta} \right] (f_D)^{\Theta}
\]

\[
(B_c) \frac{\phi}{\kappa} = \frac{\delta f_E}{f_D} \Theta (f_D P^e) \frac{\phi}{\kappa} = \frac{\phi}{\kappa} \left( \frac{P_c^e}{P^e} \right)^{-\kappa} \left( \frac{f_X^e}{f_X} \right)^{\Theta}
\]  
(A.4.3)

A.5 Deriving the equilibrium cutoffs

Using the expression for $B_c$ in (3.21) and (3.26); (3.32) implies that:

\[
(B_c) \frac{1}{\phi} = (f_D P^e) \frac{1}{\phi} \left[ \frac{f_E}{f_D} \Theta \left( \frac{1 - \tau^{-k} \left( \frac{P_c^e}{P^e} \right)^{-\kappa} \left( \frac{f_X^e}{f_X} \right)^{\Theta}}{1 - \tau^{-2k} \left( \frac{f_D}{f_X} \right)^{2\kappa}} \right) \right]^{-1}
\]  
(A.5.1)
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From (3.21)

$$
\phi^c = \left[ P^c_f D (B_c)^{-1} \right]^{\frac{1}{1-\tau}}
$$

$$
\begin{aligned}
&\frac{d}{fd} \left( 1 - \tau^{-\kappa} \left( \frac{P^c_f}{P^c_i} \right)^{\frac{\kappa}{1-\tau}} \left( \frac{f_d}{f_x} \right)^{2\kappa} \right) \\
&= \frac{1}{\tau} \left[ \delta \left( \frac{f_d}{f_x} \right)^{\frac{1}{\tau}} \left( \frac{1 - \tau^{-\kappa} \left( \frac{P^c_f}{P^c_i} \right)^{\frac{\kappa}{1-\tau}} \left( \frac{f_d}{f_x} \right)^{2\kappa}}{1 - \tau^{-2\kappa} \left( \frac{f_d}{f_x} \right)^{2\kappa}} \right) \right]^{\frac{1}{\tau-1}}
\end{aligned}
$$

(A.5.2)

From (3.26)

$$
\phi^{x^*} = \left( P^c_f D (B_c)^{-1} \right) \frac{1}{\tau} \left( \frac{P^c_f}{P^c_i} \right) \left( f_d P^c_i \right)^{\frac{1}{\tau-1}}
$$

$$
\begin{aligned}
&\frac{d}{fd} \left( 1 - \tau^{-\kappa} \left( \frac{P^c_f}{P^c_i} \right)^{\frac{\kappa}{1-\tau}} \left( \frac{f_d}{f_x} \right)^{2\kappa} \right) \\
&= \left( \frac{P^c_f f_d}{P^c_i f_d} \right)^{\frac{1}{\tau-1}} \left( \frac{P^c_f}{P^c_i} \right) \left( \frac{f_d}{f_x} \right)^{\frac{1}{\tau-1}} \left[ \delta \left( \frac{f_d}{f_x} \right)^{\frac{1}{\tau}} \left( \frac{1 - \tau^{-\kappa} \left( \frac{P^c_f}{P^c_i} \right)^{\frac{\kappa}{1-\tau}} \left( \frac{f_d}{f_x} \right)^{2\kappa}}{1 - \tau^{-2\kappa} \left( \frac{f_d}{f_x} \right)^{2\kappa}} \right) \right]^{\frac{1}{\tau-1}}
\end{aligned}
$$

(A.5.3)
A.6 Equilibrium distributions

Taking into account the equilibrium cutoffs and combining them with the assumption of Pareto distributed productivity we get:

\[
(\tilde{\phi}_c)^{\sigma-1} = \frac{\kappa}{\kappa - \sigma + 1} \left[ \delta \frac{f_E}{f_D} \Theta \left( \frac{1 - \tau^{-\kappa} \left( \frac{p^*_I}{p^*_F} \right)^{\frac{\sigma}{\sigma-1}} \left( \frac{f_D}{f_X} \right)^{\Theta}}{1 - \tau^{-2\kappa} \left( \frac{f_D}{f_X} \right)^{2\Theta}} \right) \right]^{\frac{1-\sigma}{\kappa}} \tag{A.6.1}
\]

\[
(\tilde{\phi}_c^X)^{\sigma-1} = \frac{\kappa}{\kappa - \sigma + 1} \left( \frac{P^*_I}{P^*_F} \right)^{\alpha} \left( \frac{f_X}{f_D} \right)^{\alpha-1} \left[ \delta \frac{f_E}{f_D} \Theta \left( \frac{1 - \tau^{-\kappa} \left( \frac{p^*_I}{p^*_F} \right)^{\frac{\sigma}{\sigma-1}} \left( \frac{f_D}{f_X} \right)^{\Theta}}{1 - \tau^{-2\kappa} \left( \frac{f_D}{f_X} \right)^{2\Theta}} \right) \right]^{\frac{1-\sigma}{\kappa}} \tag{A.6.2}
\]

The average productivity of all active firms in each country

\[
(\tilde{\phi}_T^c)^{\sigma-1} = \frac{1}{N^c} \frac{\kappa}{\kappa - \sigma + 1} \left[ \delta \frac{f_E}{f_D} \Theta \left( \frac{1 - \tau^{-\kappa} \left( \frac{p^*_I}{p^*_F} \right)^{\frac{\sigma}{\sigma-1}} \left( \frac{f_D}{f_X} \right)^{\Theta}}{1 - \tau^{-2\kappa} \left( \frac{f_D}{f_X} \right)^{2\Theta}} \right) \right]^{\frac{1-\sigma}{\kappa}} \times \left( \frac{P^*_I}{P^*_F} \right)^{\frac{1-\sigma\delta}{\delta}} \left( \frac{f_D}{f_X} \right)^{\Theta} \left( \frac{1 - \tau^{-\kappa} \left( \frac{p^*_I}{p^*_F} \right)^{\frac{\sigma}{\sigma-1}} \left( \frac{f_D}{f_X} \right)^{\Theta}}{1 - \tau^{-2\kappa} \left( \frac{f_D}{f_X} \right)^{2\Theta}} \right)^{N^c} \tag{A.6.3}
\]

Substituting for \( \tilde{\phi}_T^c \) from (A.6.3) into (A.1.14) the price index becomes:
A.7 Deriving the Equilibrium Number of Firms

To derive the equilibrium number of firms, combine the definition of the market demand term in each country \( B_c \) with the equilibrium expression (3.32).

\[
B_c = \frac{1}{\sigma} (1 - \mu) w_c L_c^\sigma \left( \frac{\sigma}{\sigma - 1} P_c^\kappa \right)^{1 - \sigma}
\]  

(A.7.5)

Replacing for \( P_c \) from (A.6.4)

\[
P_c = \frac{\sigma}{\sigma - 1} P_c^\kappa \left[ \frac{\delta f \Theta}{f D} \right] \left( \frac{1 - \tau - \kappa \left( P_c I P_c' I \right)}{1 - \tau - 2 \kappa (f D f X)^\Theta} \right)^{\frac{1}{\kappa}} \]

\[
= \frac{\frac{\kappa}{\kappa - \sigma + 1}}{N_c + \tau - \kappa \left( \frac{P_c'}{P_c} \right)^{-\sigma + \alpha - 1} \left( \frac{f D}{f X} \right)^\Theta \left( 1 - \tau - \kappa \left( \frac{P_c}{P_c'} I \right) - \frac{\sigma \kappa}{\sigma - 1} \frac{(f D f X)^\Theta}{f D f X^\Theta} \right)^{N_c'}}
\]

(A.7.6)
From (3.32)

\[ B_c = f_D P_I^{f} \left[ \frac{\delta f_E}{f_D} \Theta \left( 1 - \tau^{-\kappa} \left( \frac{P}{P^c} \right)^{\frac{\sigma - \alpha + 1}{\sigma - 1}} \left( \frac{f_D}{f_X} \right)^\Theta \right) \right]^{\frac{\sigma - 1}{\tau}} \]  

(A.7.7)

Hence

\[ N^c = \frac{(1 - \mu) \left( \epsilon - \sigma + 1 \right)}{1 - \tau^{-2\kappa} \left( \frac{f_D}{f_X} \right)^{2\gamma}} \]  

(A.7.8)

The mass of exporters is given by

\[ N_X^c = f_{n}^c N_c \]

where

\[ f_{n}^c = \frac{1 - G(\phi^* | c)}{\phi^* (\phi^*)^\kappa} \]  

stands for the probability of exporting, but also the share of firms that export, which under the Pareto specification becomes

\[ f_{n}^c = \left( \frac{\phi^*_{f}}{\phi^*_{c}} \right)^\kappa \]  

Replacing for the equilibrium cutoffs from the previous section, we shall have that the probability of exporting and the mass of exporters are respectively given by the following expressions.

\[ N^c = \frac{(1 - \mu) \left( \epsilon - \sigma + 1 \right)}{1 - \tau^{-2\kappa} \left( \frac{f_D}{f_X} \right)^{2\gamma}} \]  

(A.7.9)

The mass of exporters is given by

\[ N_X^c = f_{n}^c N_c \]

where

\[ f_{n}^c = \frac{1 - G(\phi^* | c)}{\phi^* (\phi^*)^\kappa} \]  

stands for the probability of exporting, but also the share of firms that export, which under the Pareto specification becomes

\[ f_{n}^c = \left( \frac{\phi^*_{f}}{\phi^*_{c}} \right)^\kappa \]  

Replacing for the equilibrium cutoffs from the previous section, we shall have that the probability of exporting and the mass of exporters are respectively given by the following expressions.

\[ 53 f_{n}^c N^c = \delta N^c \Rightarrow N^c = \frac{\delta N^c}{f_{n}^c} \quad N^c = \delta N^c \left( \frac{\phi^*_{f}}{\phi^*_{c}} \right)^\kappa \]
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\[ f_{x}^{c} = \tau^{-k} \left( \frac{P_{c}^{L}}{P_{T}^{d}} \right)^{\frac{\kappa}{1-\kappa}} \left( \frac{f_{D}}{f_{X}} \right)^{\frac{\Theta}{1-\Theta}} \left( 1 - \tau^{-k} \left( \frac{P_{c}^{L}}{P_{T}^{d}} \right)^{\frac{\kappa}{1-\kappa}} \left( \frac{f_{D}}{f_{X}} \right)^{\Theta} \right) \]

(A.7.10)

\[ N_{c}^{X} = \frac{1}{f_{X}} \left( \frac{\kappa - \sigma + 1}{\kappa} \right) \frac{\tau^{-k} \left( \frac{f_{D}}{f_{X}} \right)^{\Theta}}{1 - \tau^{-2k} \left( \frac{f_{D}}{f_{X}} \right)^{2\Theta} \Phi_{f}^{c}} \]

(A.7.11)

where

\[ \Phi_{f}^{c} = \left( \frac{1}{\Phi_{f}^{c}} \right)^{\frac{1}{\Phi_{f}^{c}}} \]

(A.7.12)

The total number of active firms on a given market (and therefore also the number of different varieties available to the consumers in that market) consists of the sum of active domestic firms and foreign exporters in equilibrium, i.e.

\[ N_{T}^{c} = N_{c}^{c} + N_{c}^{X} = N_{c}^{c} + f_{x}^{c'} N_{c}^{d'} . \]

(A.7.13)
A.8 Deriving the Equilibrium Price Indices

Replace for $N^c$, from (3.35) in (A.6.4):

$$P_c^e = \frac{\sigma}{\sigma - 1} \left( p_f^c \right)^{\frac{\alpha - 1}{\alpha}} \left( \frac{1 - \mu \, w_c \, \ell^c}{\ell^D} \right)^{\frac{1}{\lambda}}$$

$$\times \left[ \frac{f_E}{f_D} \left( \frac{\kappa - \sigma + 1}{\sigma - 1} \right) \left( 1 - \tau^{-\kappa} \left( \frac{p_f^c}{P_f^c} \right)^{-\frac{\sigma}{\alpha}} \left( \frac{L^c}{L^X} \right) \right) \right]^{\frac{1}{\tau}} \quad \text{(A.8.14)}$$

A.9 Welfare

$$w_c = w_c^{P_c^e} = \frac{\sigma - 1}{\sigma} \left( \frac{1 - \mu \, \ell^c}{\ell^D} \right)^{\frac{1}{s-1}} \left( \frac{f_D}{f^X} \right)^{\frac{s-1}{s-1}} \left[ \frac{f_E}{f_D} \left( \frac{\kappa - \sigma + 1}{\sigma - 1} \right) \left( 1 - \tau^{-\kappa} \left( \frac{p_f^c}{P_f^c} \right)^{-\frac{\sigma}{\alpha}} \left( \frac{L^c}{L^X} \right)^{\alpha} \right) \right]^{\frac{1}{\tau}} \quad \text{(A.9.1)}$$

A.10 Parameter Restrictions

$$\kappa > \sigma - 1 \quad \text{(A.10.1)}$$

This requirement is needed given that the support for the Pareto distribution is unbounded from above and the assumption of a continuum of firms. If either assumption is relaxed (finite number of firms or a truncated Pareto distribution), then this condition needs not be imposed. In fact the empirical estimates of the shape parameter $\frac{\kappa}{\sigma - 1}$ are below one for some sectors.
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A.10.1 Selection

I would like the cutoffs to lie above $\phi_{\min} = 1$. If not then there will be no selection. In other words, if $\phi_c^* < 1$ then all entrants will survive on the domestic market. Moreover if $\phi_c^{X*} < 1$ then all domestic firms are also exporters

$$\phi_c^* > 1 \iff \frac{\delta f_E}{f_D} \left( \frac{1 - \tau^{-\kappa} \left( \frac{P_c'}{P_c^I} \right) \frac{f_X}{f_X}}{1 - \tau^{-2\kappa} \left( \frac{f_D}{f_X} \right)^{2\kappa}} \right)^{\frac{1}{\kappa}} > 1 \quad (A.10.2)$$

$$\phi_c^{X*} > 1 \iff \tau \left( \frac{P_c'}{P_c^I} \right)^{\frac{\sigma}{\sigma - 1}} \left( \frac{f_X}{f_D} \right)^{\frac{1}{\sigma - 1}} \left( \frac{\delta f_E}{f_D} \left( \frac{1 - \tau^{-\kappa} \left( \frac{P_c'}{P_c^I} \right) \frac{f_X}{f_X}}{1 - \tau^{-2\kappa} \left( \frac{f_D}{f_X} \right)^{2\kappa}} \right)^{\frac{1}{\kappa}} > 1 \quad (A.10.3)$$

A.10.2 Partition

We assume that exporters are more productive that purely domestic firms

$$\phi_c^{X*} > \phi_c^* \iff$$

$$\frac{P_c'}{P_c^I} \left( f_X f_D \right)^{\frac{1}{\sigma - 1}} \left[ \delta f_E \Theta \left( \frac{1 - \tau^{-\kappa} \left( \frac{P_c'}{P_c^I} \right) \frac{f_X}{f_X}}{1 - \tau^{-2\kappa} \left( \frac{f_D}{f_X} \right)^{2\kappa}} \right)^{\frac{1}{\kappa}} \right] > 1 \quad (A.10.4)$$
A.10.3 Non-negative mass of firms

\[ N^c \geq 0 \Leftrightarrow \left( 1 - \tau^{-\kappa} \left( \frac{P^c}{P^f} \right)^{\frac{\sigma}{\sigma - 1}} \left( \frac{L_P}{L_P'} \right)^{\Theta} \left( 1 + R \frac{L_P'}{L_P} \right) + \tau^{-2\kappa} \left( \frac{f_D}{f_X} \right)^{2\Theta} R \frac{L_P'}{L_P} \right) \left( 1 - \tau^{-\kappa} \left( \frac{P^c}{P^f} \right)^{\frac{\sigma}{\sigma - 1}} \left( \frac{f_D}{f_X} \right)^{\Theta} \right) \geq 0 \]  
(A.10.5)

A.10.4 Non-negative price indices

\[ P^c \geq 0 \Leftrightarrow \left( 1 - \tau^{-\kappa} \left( \frac{P^c}{P^f} \right)^{\frac{\sigma}{\sigma - 1}} \left( \frac{f_D}{f_X} \right)^{\Theta} \right) \geq 0 \]  
(A.10.6)

A.10.5 Further technical restrictions

The ex-post probability of exporting (or fraction of firms that export) lies in the interval \([0, 1]\)

\[ 0 \leq f_x^c = \tau^{-\kappa} \left( \frac{P^f}{P^c} \right)^{\frac{\sigma}{\sigma - 1}} \left( \frac{f_D}{f_X} \right)^{\Theta} \leq 1 \]  
(A.10.7)

\[ \Leftrightarrow 0 \leq \frac{1 - \tau^{-\kappa} \left( \frac{P^c}{P^f} \right)^{\frac{\sigma}{\sigma - 1}} \left( \frac{f_D}{f_X} \right)^{\Theta}}{1 - \tau^{-\kappa} \left( \frac{P^c}{P^f} \right)^{\frac{\sigma}{\sigma - 1}} \left( \frac{f_D}{f_X} \right)^{\Theta}} \leq \tau^{-\kappa} \left( \frac{P^f}{P^c} \right)^{\frac{\sigma}{\sigma - 1}} \left( \frac{f_D}{f_X} \right)^{\Theta} \leq 1 \]  
(A.10.8)

\[ \tau^{-\kappa} \left( \frac{P^f}{P^c} \right)^{\frac{\sigma}{\sigma - 1}} \left( \frac{f_D}{f_X} \right)^{\Theta} \leq 1 \]  
(A.10.9)
The ex-post probability of survival on the domestic market (or fraction of entrants that survive) lies in the interval $[0, 1]$

$$0 \leq f_m^c = \delta \frac{f_E \Theta}{f_D} \left( \frac{1 - \tau^{-\kappa} \left( \frac{P_c}{P_t^e} \right)^{-\frac{\kappa}{1-\tau}} \left( \frac{f_D}{f_X} \right)^{\Theta}}{1 - \tau^{-2\kappa} \left( \frac{f_D}{f_X} \right)^{2\Theta}} \right) \leq 1$$  \hspace{1cm} (A.10.10)

$$0 \leq \left( \frac{1 - \tau^{-\kappa} \left( \frac{P_c}{P_t^e} \right)^{-\frac{\kappa}{1-\tau}} \left( \frac{f_D}{f_X} \right)^{\Theta}}{1 - \tau^{-2\kappa} \left( \frac{f_D}{f_X} \right)^{2\Theta}} \right) \leq 1$$  \hspace{1cm} (A.10.11)

$$\delta \frac{f_E \Theta}{f_D} \left( \frac{1 - \tau^{-\kappa} \left( \frac{P_c}{P_t^e} \right)^{-\frac{\kappa}{1-\tau}} \left( \frac{f_D}{f_X} \right)^{\Theta}}{1 - \tau^{-2\kappa} \left( \frac{f_D}{f_X} \right)^{2\Theta}} \right) \leq 1$$  \hspace{1cm} (A.10.12)

### A.10.6 Bringing all the restrictions together

The restriction on the price index (A.10.6) implies that:

$$P_c^e \geq 0 \iff \left( \frac{1 - \tau^{-\kappa} \left( \frac{P_c}{P_t^e} \right)^{-\frac{\kappa}{1-\tau}} \left( \frac{f_D}{f_X} \right)^{\Theta}}{1 - \tau^{-2\kappa} \left( \frac{f_D}{f_X} \right)^{2\Theta}} \right) \geq 0$$  \hspace{1cm} (A.10.13)

the following terms should all have the same sign.

$$1 - \tau^{-\kappa} \left( \frac{P_c}{P_t^e} \right)^{-\frac{\kappa}{1-\tau}} \left( \frac{f_D}{f_X} \right)^{\Theta}$$

$$1 - \tau^{-\kappa} \left( \frac{P_c}{P_t^e} \right)^{-\frac{\kappa}{1-\tau}} \left( \frac{f_D}{f_X} \right)^{\Theta}$$

$$1 - \tau^{-2\kappa} \left( \frac{f_D}{f_X} \right)^{2\Theta}$$  \hspace{1cm} (A.10.14)
Assume that:

$$1 - \tau^{-2\kappa} \left( \frac{f_D}{f_X} \right)^{2\theta} \geq 0 \iff \tau^\kappa f_X \geq f_D \quad (A.10.15)$$

Then we have that:

$$1 - \tau^{-\kappa} \left( \frac{P_c}{P^*_I} \right)^{\frac{\sigma}{\kappa \sigma}} \left( \frac{f_D}{f_X} \right)^{\theta} \geq 0 \quad (A.10.16)$$

$$1 - \tau^{-\kappa} \left( \frac{P_c}{P^*_I} \right)^{\frac{\sigma}{\kappa \sigma}} \left( \frac{f_D}{f_X} \right)^{\theta} \geq 0 \quad (A.10.17)$$

(A.10.6), as well as (A.10.16) and (A.10.17) render (A.10.7), (A.10.11) redundant.

Using in (A.10.2), (3.34) the restrictions implied by (A.10.6) become:

$$\delta \frac{f_E}{f_D} \Theta \left( \frac{1 - \tau^{-\kappa} \left( \frac{P_c}{P^*_I} \right)^{\frac{\sigma}{\kappa \sigma}} \left( \frac{f_D}{f_X} \right)^{\theta}}{1 - \tau^{-2\kappa} \left( \frac{f_D}{f_X} \right)^{2\theta}} \right) < 1 \quad (A.10.18)$$

$$\delta \frac{f_E}{f_D} \Theta \left( \frac{1 - \tau^{-\kappa} \left( \frac{P_c}{P^*_I} \right)^{\frac{\sigma}{\kappa \sigma}} \left( \frac{f_D}{f_X} \right)^{\theta}}{1 - \tau^{-2\kappa} \left( \frac{f_D}{f_X} \right)^{2\theta}} \right) < 1 \quad (A.10.19)$$

From (3.34)

$$\tau \left( \frac{P^*_I}{P^*_I} \right)^{\frac{\sigma}{\kappa \sigma}} \left( \frac{f_X}{f_D} \right) \frac{1}{\tau^\frac{1}{2}} \left[ \delta \frac{f_E}{f_D} \Theta \left( \frac{1 - \tau^{-\kappa} \left( \frac{P_c}{P^*_I} \right)^{\frac{\sigma}{\kappa \sigma}} \left( \frac{f_D}{f_X} \right)^{\theta}}{1 - \tau^{-2\kappa} \left( \frac{f_D}{f_X} \right)^{2\theta}} \right) \right]^{\frac{1}{2}} > 1 \quad (A.10.20)$$
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combining with (A.10.8)

\[ \tau^{-\kappa} \left( \frac{P^c_L}{P^c_I} \right)^{\frac{\kappa}{\tau-\kappa}} \left( \frac{f_D}{f_I} \right)^{\frac{\kappa}{\tau-\kappa}} \left( \frac{1 - \tau^{-\kappa} \left( \frac{P^c_L}{P^c_I} \right)^{\frac{\kappa}{\tau-\kappa}} \left( \frac{f_D}{f_I} \right)^{\Theta}}{1 - \tau^{-\kappa}} \right)^\tau \leq 1 \]  
(A.10.21)

we have from (3.34)

\[ \tau^{-1} \left( \frac{P^c_I}{P^c_L} \right)^{-\frac{\kappa}{\tau-\kappa}} \left( \frac{f_X}{f_D} \right)^{-\frac{1}{\tau-\kappa}} \left( \frac{\delta f_E}{f_D} \Theta \left( \frac{1 - \tau^{-\kappa} \left( \frac{P^c_I}{P^c_L} \right)^{\frac{\kappa}{\tau-\kappa}} \left( \frac{f_D}{f_X} \right)^{\Theta}}{1 - \tau^{-\kappa}} \right)^\tau \right) < 1 \]
(A.10.22)

raising in the power \( \kappa \)

\[ \tau^{-\kappa} \left( \frac{P^c_I}{P^c_L} \right)^{-\frac{\kappa}{\tau-\kappa}} \left( \frac{f_X}{f_D} \right)^{-\frac{1}{\tau-\kappa}} \left[ \delta f_E \Theta \left( \frac{1 - \tau^{-\kappa} \left( \frac{P^c_I}{P^c_L} \right)^{\frac{\kappa}{\tau-\kappa}} \left( \frac{f_D}{f_X} \right)^{\Theta}}{1 - \tau^{-\kappa}} \right)^\tau \right] < 1 \]
(A.10.23)

so (A.10.8) is now redundant. Going back to the partition assumptions,

\[ \tau \left( \frac{P^c_I}{P^c_L} \right)^{\frac{\kappa}{\tau}} \left( \frac{f_X}{f_D} \right)^{\frac{1}{\tau}} \left[ \delta f_E \Theta \left( \frac{1 - \tau^{-\kappa} \left( \frac{P^c_I}{P^c_L} \right)^{\frac{\kappa}{\tau}} \left( \frac{f_D}{f_X} \right)^{\Theta}}{1 - \tau^{-\kappa}} \right)^\tau \right] ^{-\frac{1}{\tau}} < 1 \]
(A.10.24)
raise to $-\kappa$

$$
\tau^{-\kappa} \left( \frac{P^c}{P^e} \right)^{-\frac{\sigma - 1}{\sigma}} \left( \frac{f_D}{f_X} \right)^{\frac{\sigma}{\sigma - 1}} \left( 1 - \tau^{-\kappa} \left( \frac{P^c}{P^e} \right)^{-\frac{\sigma - 1}{\sigma}} \left( \frac{f_D}{f_X} \right)^{\Theta} \right) < \left( 1 - \tau^{-\kappa} \left( \frac{P^c}{P^e} \right)^{-\frac{\sigma - 1}{\sigma}} \left( \frac{f_D}{f_X} \right)^{\Theta} \right) \iff 
$$

$$
\tau^{-\kappa} \left( \frac{P^c}{P^e} \right)^{-\frac{\sigma - 1}{\sigma}} \left( \frac{f_D}{f_X} \right)^{\frac{\sigma}{\sigma - 1}} \frac{1 - \tau^{-\kappa} \left( \frac{P^c}{P^e} \right)^{-\frac{\sigma - 1}{\sigma}} \left( \frac{f_D}{f_X} \right)^{\Theta}}{1 - \tau^{-\kappa} \left( \frac{P^c}{P^e} \right)^{-\frac{\sigma - 1}{\sigma}} \left( \frac{f_D}{f_X} \right)^{\Theta}} < 1 
$$

(A.10.26)

The non-negativity restrictions for the number of firms (A.10.5) are reduced to

$$
N^c \geq 0 \iff 1 - \tau^{-\kappa} \left( \frac{P^c}{P^e} \right)^{-\frac{\sigma - 1}{\sigma}} \left( \frac{f_D}{f_X} \right)^{\Theta} \left( 1 + \mathcal{R}' \frac{L'}{L'} \right) + \tau^{-2\kappa} \left( \frac{f_D}{f_X} \right)^{2\Theta} \frac{L'}{L'} \geq 0
$$

(A.10.27)

Summing up:

$$
\kappa > \sigma - 1
$$

(A.10.28)

$$
1 - \tau^{-2\kappa} \left( \frac{f_D}{f_X} \right)^{2\Theta} \geq 0 \iff \tau^\sigma f_X \geq f_D
$$

(A.10.29)

$$
1 - \tau^{-\kappa} \left( \frac{P^c}{P^e} \right)^{-\frac{\sigma - 1}{\sigma}} \left( \frac{f_D}{f_X} \right)^{\Theta} \geq 0
$$

(A.10.30)
\[
\delta \frac{f_E}{f_D} \Theta \left( \frac{1 - \tau^{-\kappa} \left( \frac{P_E}{P_I^0} \right)^{\frac{\kappa}{\sigma-1}} \left( \frac{f_D}{f_X} \right)^\Theta}{1 - \tau^{-2\kappa} \left( \frac{f_D}{f_X} \right)^{2\Theta}} \right) < 1 
\]

(A.10.31)

\[
\tau^{-\kappa} \left( \frac{P_E}{P_I^0} \right)^{-\frac{\kappa}{\sigma-1}} \left( \frac{f_D}{f_X} \right)^\frac{\kappa}{\sigma-1} \left[ \delta \frac{f_E}{f_D} \Theta \left( \frac{1 - \tau^{-\kappa} \left( \frac{P_E}{P_I^0} \right)^{\frac{\kappa}{\sigma-1}} \left( \frac{f_D}{f_X} \right)^\Theta}{1 - \tau^{-2\kappa} \left( \frac{f_D}{f_X} \right)^{2\Theta}} \right) \right] < 1
\]

(A.10.32)

\[
\tau^{-\kappa} \left( \frac{P_E}{P_I^0} \right)^{-\frac{\kappa}{\sigma-1}} \left( \frac{f_D}{f_X} \right)^\frac{\kappa}{\sigma-1} \frac{1 - \tau^{-\kappa} \left( \frac{P_E}{P_I^0} \right)^{\frac{\kappa}{\sigma-1}} \left( \frac{f_D}{f_X} \right)^\Theta}{1 - \tau^{-2\kappa} \left( \frac{f_D}{f_X} \right)^{2\Theta}} < 1
\]

(A.10.33)

\[
1 - \tau^{-\kappa} \left( \frac{P_E}{P_I^0} \right)^{-\frac{\kappa}{\sigma-1}} \left( \frac{f_D}{f_X} \right)^\Theta \left( 1 + \frac{1}{R} \frac{L^c}{L'} \right) + \tau \left( \frac{f_D}{f_X} \right)^{2\Theta} \frac{1}{R} \frac{L^c}{L'} \geq 0
\]

(A.10.34)
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