Exploring the Barriers to Globalization

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Acknowledgments

Writing the essays that compose this thesis has been a greatly rewarding endeavor, and I have learnt a great deal during the three years, from May 2008 to April 2011, that it has taken to write them. I am thankful to my supervisor Prof. Philipp Schröder and co-supervisor Prof. Jørgen Ulff-Møller Nielsen, for first ensnaring me into the PhD program at Aarhus School of Business and for thereafter providing support, encouragement, heartening pep-talks and beer and Grünkohl.

Throughout my thesis, Aarhus School of Business has proven to be an excellent workplace; when I compare my conditions to those of PhD students from other institutions that I’ve encountered, whether in Denmark or abroad, it is clear that doing a PhD at Aarhus School of Business is a privilege. Part of this privilege are the fabulous secretaries Susan Stilling, Camilla Mikkelsen and Ann-Marie Gabel, and I owe them great thanks for their help with all the practical problems that I ran into (and those were many). Another privilege was colleagues and my fellow PhD students. Thanks are especially due to my wonderful office mate Sanne Hiller for enlightening discussions, and to Prof. Frédéric Warczynski.

Other institutions have hosted me as well, and I wish to thank Prof. Marie-Claire Villeval for arranging a visit to Groupe d’Analyse et Théorie Economique at Université de Lyon from November 2008 to June 2009. During this period, I was also allowed an informal association with Centre d’Économie de la Sorbonne, Université de Paris I, which Prof. Thierry Mayer was so kind to allow. Part of this thesis has been written in Copenhagen, and I thank Prof. Pascalis Ramondos-Møller for allowing me to work at Copenhagen Business School and Prof. Jakob Roland Munch for finding me an office at University of Copenhagen.

Generous travel grants have allowed me to present my work widely and meet several scholars at foreign institutions, who have provided valuable feedback and inspiration. I especially wish to thank Prof. Peter Neary, University of Oxford, Prof. Horst Raff, Christian-Albrechts-Universität zu Kiel, Prof. Holger Görg, Kiel Institute for the World Economy, Prof. Thierry Mayer, Sciences Po. Paris, Prof. Farid Toubal, Centre d’Économie de la Sorbonne, Prof. Hylke Vandenbussche, Université Catholique de Louvain-la-Neuve and Prof. Stephen Yeaple, Pennsylvania State University.

For the essay “The Declining Barriers to Foreign Direct Investments and How to See Them”, I am grateful to the following people for comments and


For the essay “Anti-Dumping with Heterogeneous Firms”: Gianmarco Ottaviano, Allan Sørensen and Hylke Vandenbussche, as well as two anonymous referees from Economie Internationale.

On the personal front, thanks are highly due to my family, especially my coming wife Lauréline. Thank you for supporting me, encouraging me, consoling me, and for getting my mind away from the equations when necessary.
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Non-technical summary of thesis

This thesis consists of three individual essays with the barriers to globalization as common theme. The forms of globalization considered are trade in goods and foreign direct investments (FDI). For FDI, I examine all aggregate barriers between countries, and what they consist of, in the essay “The Declining Barriers to Foreign Direct Investment and How to See Them”. The barriers to trade in goods have been studied more thoroughly by the economic literature, and I therefore consider two special forms of trade barriers. In “Intransparent Markets and Intra-Industry Trade”, I examine how information barriers interact with international trade. In “Antidumping with Heterogeneous Firms”, I analyze the trade policy antidumping.

The essays of this thesis are worked out individually, as articles for academic publishing. Antidumping with Heterogeneous Firms has been revised and resubmitted to Economie Internationale. Intransparent Markets and Intra-Industry Trade is being submitted (again), and The Declining Barriers to Foreign Direct Investments and How to See Them will be submitted shortly.

In the first essay, “The Declining Barriers to Foreign Direct Investments and How to See Them”, I measure the barriers to foreign direct investment (FDI) between countries. Firms carry out FDI when they acquire existing firms or set up new firms in other countries. The value of those firms in one country that firms in another country own is measured by the stock of FDI between the two countries. It is the barriers to this cross-border firm ownership that I examine. Many of these barriers to FDI are hard to observe, think for instance of coordination costs between a parent firm and its affiliate in another country, and the economic literature has therefore had a hard time studying them, let alone saying how large they are.

FDI stocks between countries can be predicted very well by an empirical regularity called “the gravity equation” (a regularity that also holds for international trade). The gravity equation gives us a prediction of how much FDI we would expect between a pair of countries. In the essay, I compare the gravity equation’s predictions to actual FDI data, and from that I compute the barriers to FDI that are consistent with the observed stocks.

This methodology amounts to scaling down how much FDI two countries do with each other by how much FDI they do with themselves. I measure a country’s FDI with itself as the country’s total capital stock minus the amount of this capital that other countries have bought. The measure that comes out,
call it $\phi$, is an inverse measure of the FDI barrier: If $\phi$ for Germany and France is 0.10, it means that it is 0.10 times as attractive for German firms to own firms in France and for French firms to own firms in Germany than it is for French and German firms to own firms at home.

In this manner, I get a measure of the barriers to FDI between pairs of 28 OECD countries that I can follow over the period 1985 to 2008. The world’s lowest barrier to FDI is between the Netherlands and the UK: in 2007, it was 0.23 times as attractive to own firms between the two countries as it was to own domestic firms. The barriers to FDI have been falling rather quickly, over the examined time period they are on average halved every 5 years.

With regression analysis, I examine what the FDI barriers consist of. It turns out that many barriers to FDI are country-specific. Wealthy countries have lower barriers, as do English-speaking countries. The countries with the lowest corporate tax rates (The Netherlands, Ireland and Switzerland) have especially low barriers to FDI.

FDI barriers that are specific to country pairs relate primarily to distance (a 1% increase in distance between two countries raises their FDI barrier by 0.46%), and to whether the two countries have historically been one country, which lowers the barrier by 58%. A common borders or a common language also reduces FDI barriers, and wealthier and larger countries have lower barriers between them.

As a final exercise, I decompose the growth in FDI. 75% of the growth in FDI is caused by lower bilateral barriers, 32% comes from economic growth (if countries grow, they would want their FDI stocks to follow). The excess 7% is a negative contribution from “bidder competition”: Imagine you’re a Spanish firm, and you want to buy a German firm. If Germany has low barriers to the rest of the world, you have to compete with many other firms to win the bid for the German firm. Because barriers to FDI have declined, we get this negative contribution from third-country barriers.

“Intransparent Markets and Intra-Industry Trade”, the second essay, uncovers intricate relationships between information barriers and international trade. The starting point is that most real-world markets are what I call ‘intransparent’: When buyers want to buy something, they do not necessarily know who sells the good or what price is being charged. Sellers therefore spend considerable resources on advertisement, to make buyers aware of the goods they are selling. When buyers finally find the good that they wish to buy, they typically
don’t know if they could have found a better offer for the good somewhere else.

Along these lines, I construct a model with sellers and buyers. Sellers need to advertise their offer to buyers if they want to sell their goods, but they cannot completely control which buyers see their offers. In particular, it is too costly for a seller to advertise her offer to all possible buyers. The more a seller advertises, the more likely it is that the buyers that see the advertisements have already seen another of the seller’s advertisements.

In the model, sellers are selling completely identical goods, but that does not imply that all the goods will have the same price. Perhaps the buyer that the seller’s advertisement reaches has received no other offers. In that case, it would be best for the seller to have set a high price. Perhaps the buyer has seen advertisements from several sellers, and in that case it’s better to have set a low price to outcompete the other offers. In fact, the best pricing strategy for sellers is to randomly select their prices in such a manner that the gains from setting higher or lower prices cancel each other out.

On the market there are therefore both sellers setting high prices and selling few units (but earning handsome profit margins on these units), sellers that set at low prices and sell many units (with low profit margins), and sellers with all levels of intermediate prices. All these sellers earn the same amount of total profits.

To the observer, this market looks like what is predicted in models with heterogeneous firms, which are now standard in international trade. In for example Melitz (2003), firms have different costs, and the higher costs a firm has, the higher price it sets and the less it sells. My model generates exactly the same pattern with identical firms, suggesting that some of the differences between firms that we observe may just be similar firms following different, but equally profitable, pricing strategies.

The ‘intransparency’ on the market generates a motive for international trade: A seller can try to advertise her good to a foreign buyer as well; perhaps her offer is the best that the foreign buyer will get. When I allow for international trade in the model, buyers will on average get more offers. This means that prices fall on the markets: when buyers receive more offers, it gets more important for sellers to try to offer a lower price than other sellers. Buyers therefore benefit from international trade.

International trade has similar effects in this model and in models with heterogeneous firms: Trade drives average prices down, and fewer firms will set very high prices. Moreover, in trade data, there are some exporters that
only export very little and do so infrequently. The standard models with heterogeneous firms have a hard time explaining this type of exporters, but in my model they appear naturally: Some sellers will export very infrequently because they offer ‘bad deals’, and it is therefore not often that they find any foreign buyers that don’t get better offers.

The information barriers analyzed in this model turn out to have surprising effects: If information could flow freely to buyers, so that they would automatically know who was selling the good and what price was charged, there would be no reason for countries to trade with each other! Competition between sellers would drive prices down to marginal costs, and there would be no incentive for sellers to sell their goods abroad.

The last essay, “Antidumping with Heterogeneous Firms” incorporates the trade policy antidumping into a model with heterogeneous firms. Antidumping is a trade policy that more and more countries have adopted in recent years; a number of developing countries have started to use it extensively, whereas until the late 1980es, it was mainly a trade policy used by rich countries. The theoretical treatment of antidumping, however, has not kept up with the importance of the trade policy. To examine what the heterogeneous firms framework can teach us about antidumping, I analyze the policy in the model of Melitz and Ottaviano (2008).

The model works as follows: There are two countries in the world, Home and Foreign. Consumers in both countries demand different varieties of a good (their utility function is a quadratic form, and their demand for each variety is therefore a linear function of its price). Each firm produces one variety, and firms differ in their marginal cost of producing their variety. To begin producing a variety (setting up a firm), a fixed cost must be paid; upon paying it, the firm learns its marginal cost.

If the firm is unlucky, it will be so unproductive that it cannot sell anything even if it sets its price equal to its marginal cost. It will therefore exit.

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1 What antidumping is: If firms in a country feel that foreign firms are selling at unfair prices, they can complain to a government authority that these foreign firms are ‘dumping’. The government authority will thereafter examine whether the foreign firms are indeed selling at “too low” prices, and if it finds them guilty, it can impose ‘antidumping tariffs’ on them to protect the domestic firms from “unfair competition”. Numerous studies have found that in practice, the use of antidumping has little to do with protecting firms from what is harmful pricing by foreign firms in any economically meaningful sense, hence the quotation marks.
immediately after entering. Otherwise, the firm will be productive enough to earn profits on its domestic market. The lower the firm’s marginal cost, the lower a price it will set, the more units it will sell, and the higher will be its profits. The marginal cost may be low enough that it pays for the firm to export. The marginal cost of exporting a good is \(\tau > 1\) times higher than the cost of selling domestically, and it is therefore only the firms with the lowest marginal costs that can earn profits abroad.

The more firms there are on a market, the less demand there is left for each firm, and the less profit each firm will have. New firms will enter until the profits are driven down to “zero expected profits”. That is, before entering (and therefore before knowing its marginal cost), a new firm would not expect to earn profits that are larger than the fixed costs of setting up a firm.

Into this model, I then introduce antidumping. I let one of the two countries, Foreign, impose antidumping in a particular manner: Foreign’s antidumping policy is so heavily enforced that firms in the other country, Home, do not dare infringing with the legislation. They therefore set their prices so that they cannot be accused of dumping.

When antidumping authorities examine whether firms dump, they compare a firm’s domestic price with its export price. From the export price, they subtract trade costs, to achieve what is called “factory gate prices”. This practice is a little peculiar, because firms that export will typically want to absorb some of their trade costs themselves, so that they can sell more. That is also the case in the model, for the exporters in Home their optimal pricing implies that they are dumping in this legal sense. To avoid being accused of dumping, firms in Home must therefore suboptimally set their export price as \(\tau\) times the price they set on their domestic market.

The best way to accomplish this pricing for Home exporters is to lower their domestic price below its optimal level, so that they can also set a lower export price. This new pricing rule forced by Foreign’s antidumping regime has a number of consequences, and will drive all of my model’s results. First of all, the exporters in Home earn less profit on both markets, Home and Foreign. In Home, the lower prices that these exporters set on their domestic market increase competition. Consumers in Home benefit, and firms in Home that are not exporting lose some profits. In Foreign, imports from Home get more expensive, and consumers lose, but Foreign’s firms benefit from this lower competition.

Moreover, some exporters in Home that earn relatively little export profits will stop exporting. For these firms, sacrificing some domestic profits (by
lowering the domestic price) to earn a little more export profits is not worth it, they can earn more by just concentrating on their domestic market and setting their optimal price there.

In the short run, this changed pricing behavior by Home’s exporters means less competition in Foreign and more competition in Home, and consumers like competition while firms don’t, so consumers in Home and firms in Foreign are better off, while Firms in Home and consumers in Foreign are worse off. In the long run, however, things are different:

In Foreign, it is now profitable to set up a new firm: The reduced imports from Home means that a new firm in Foreign will face little competition and earn a handsome profit. In Home, on the other hand, setting up a firm is unattractive, because there are much less export profits to earn on the only export market, Foreign. In the long run, more firms will therefore enter in Foreign, and fewer firms will replace firms that exit in Home. In fact, so many firms will enter Foreign that competition will rise above what it was without antidumping, and in Home competition will fall below what it was. In the long run, consumers in Home therefore lose from the reduced competition (and fewer varieties because there are fewer firms), and consumers in Foreign gain.

A country can therefore bring welfare gains to its consumers if it enforces antidumping so heavily that it affects how many firms it can support. These welfare gains, however, come on the expense of other countries. This essay is the first to present that result. In the real world, we see a number of emerging economies (Brazil, India, Mexico, Taiwan and Turkey) use antidumping very heavily, enough to substantially reduce their imports. Luckily, we don’t seem to be in a situation where all countries use antidumping very heavily. All the gains from enforcing antidumping in model comes from a country increasing how attractive for firms it is relative to other countries, if everybody enforced antidumping, no country would be relatively more attractive from it, and everybody would lose.

**References for summary** – **Litteraturhenvisninger fra resumé**
Resumé på dansk af afhandlingen

Denne afhandling består af tre essays, med barrierer for globalisering som fælles tema. Afhandlingen behandler to former for globalisering, international handel med varer og internationale direkte investeringer (IDI). For IDI undersøger jeg totale investerings-barrierer mellem lande, og hvad de består af, det sker i essayet ”The Declining Barriers to Foreign Direct Investments and How to See Them”. Barrierer for handel med varer har den økonomiske litteratur undersøgt meget grundigere, og jeg betragter derfor to specifikke former for handelsbarrierer. Andet essay ”Intransparent Markets and Intra-Industry Trade” undersøger hvordan informationsbarrierer indvirker på international handel. Tredje essay, ”Antidumping with Heterogeneous Firms”, undersøger det handelspolitiske instrument antidumping.

I det første essay, ”The Declining Barriers to Foreign Direct Investments and How to See Them”, måler jeg barriererne til internationale direkte investeringer (IDI) mellem lande. Virksomheder udfører IDI når de i andre lande køber eksisterende virksomheder eller opbygger nye virksomheder. Den samlede værdi af hvad virksomheder i et land ejer i et andet land måles af IDI-beholdningen mellem de to lande. Det er barriererne til dette virksomhedsejerskab over grænser, som jeg undersøger. Mange af disse IDI-barrierer, kan man ikke observere, tænk for eksempel på koordinations-omkostninger mellem et hovedkvarter og dets filial i udlandet; den økonomiske litteratur har derfor haft svært ved at studere dem og finde ud af hvor høje de er.

IDI beholdninger mellem lande kan forudsiges ganske nøjagtigt med en empirisk regularitet kaldet ”tyngdekraftsligningen” (the gravity equation), denne regularitet holder også for international handel med varer. Tyngdekraftsligningen giver os en forudsigelse af hvor meget IDI vi ville forvente mellem to lande. I essayet sammenligner jeg tyngdekraftsligningens forudsigelser med faktiske IDI data, og derfra udregner jeg de IDI-barrierer, som passer med de IDI beholdninger, vi faktisk observerer.

Denne metode indebærer i praksis at nedskalere IDI beholdninger mellem to lande med hvor meget IDI de udfører hos dem selv. Jeg måler et lands IDI med sig selv som landets samlede kapital-apparat minus den del, som udenlandske virksomheder m.m. har købt. Det generede mål, lad os kalde det $\phi$, er et inverse mål for IDI-barrierer: Hvis $\phi$ er 0.10 for Tyskland og Frankrig, betyder det, at det er 0.10 gange så attraktivt for tyske og franske virk-
somheder at eje virksomheder i det andet land (i Frankrig for tyske og i Tyskland for franske virksomheder), som det er, at eje virksomheder derhjemme.

På den måde får jeg et mål for IDI-barrierer, som jeg kan sammenligne mellem par af 28 OECD-lande og følge over perioden 1985 til 2008. Verdens laveste IDI-barriere er mellem Storbritannien og Holland: i 2007 var det 0.23 gange så attraktivt at eje virksomheder mellem de to lande, som det var at eje virksomheder hjemme. IDI-barriererne falder ganske hurtigt, over den undersøgte periode bliver de i gennemsnit halveret hvert 5. år.


IDI-barrierer, som er særlige for hvert par af lande er især bestemt af afstand (hvis afstanden mellem to lande øges med 1%, øges deres IDI-barriere med 0.46%), og af om de to lande historisk har været ét, dette sænker deres IDI-barriere med 58%. En fælles grænse eller et fælles sprog reducerer også IDI-barrierer, og rigere og mere befolkede lande har lavere barrierer mellem dem.

Til sidst splitter jeg væksten i IDI op i komponenter. 75% af væksten i IDI kommer fra lavere barrierer mellem lande, 32% kommer fra økonomisk vækst (hvis to landes økonomier vokser, vil IDI beholdninger følge med). De overskydende 7% kommer fra ’opkøbskonkurrence’: Forestil dig en spansk virksomhed, som ønsker at opkøbe en tysk virksomhed. Hvis Tyskland har lave barrierer for virksomhedsopkøb, så er det nemmere for den spanske virksomhed at købe, men det er også nemmere for alle andre virksomheder verden over at købe den tyske virksomhed, så der er lavere chance for at den spanske virksomhed vinder. Fordi IDI-barriererne er faldet, får vi dette negative bidrag fra barrierer med tredjelande.

"Intransparent Markets and Intra-Industry Trade”, det andet essay, afdækker komplicerede sammenhænge mellem informationsbarrierer og international handel. Udgangspunktet er, at de fleste marked er, hvad jeg kalder uigenomliggjort (intransparent): Når købere vil købe noget, ved de ikke automatisk, hvem der sælger varen eller hvad den koster. Sælgere må derfor reklamere for deres varer, for at gøre købere opmærksomme på, hvad de sælger. Når købere til sidst finder den vare, de ønsker, ved de typisk ikke, om de kunne have fået et bedre tilbud på varen et andet sted.

I modellen sælger sælgerne fuldstændig identiske varer, men det betyder ikke, at de får den samme pris. Måske har den køber, som en sælgers reklame når frem til, ikke modtaget andre tilbud; i så fald ville det være bedst for sælgeren, hvis hun havde krævet en høj pris. Måske har køberen, som ser reklamen, allerede set tilbud fra adskillige andre sælgere; i så fald ville det være bedre at have sat en lav pris for at udkonkurrere de andre tilbud. Faktisk er den bedste prissætnings-strategi at sætte sin pris tilfældigt, på en sådan måde at gevinstene ved at sætte høje og lave priser afbalancerer hinanden.

På markedet er der derfor både sælgere, som sætter høje pris og sælger få varer (som de til gengæld tjener fedt på), sælgere som sætter lave priser og sælger mange varer (med lave profitmargener), og sælgere med alle pris niveauer mellem disse. Alle sælgere på markedet regner med at tjene den samme samlede profit.


‘Uigennemsigtigheden’ på markedet motiverer international handel: En sælger kunne prøve at reklamere for sin vare til udenlandske købere også; måske er hendes tilbud det bedste, som den udenlandske køber får. Når jeg åbner for international handel i modellen, vil køberne i gennemsnit få flere tilbud. Det betyder at priserne falder på begge marked: når køberne får flere tilbud, bliver det vigtigere for sælgerne at underbyde andre sælgere med lave priser. Køberne har derfor gavn af international handel.

International handel har effekter, som minder om dem fra modeller med heterogene virksomheder: Samhandel presser priserne ned, og færre virksomheder vil sætte høje priser. Derudover er der i handelsdata en type eksportører, som kun eksporterer lidt og ganske sjældent. Standard-modeller har svært ved at forklare disse eksportører, men i min model opstår de ganske naturligt:
Visse sælgere vil eksportere meget sjældent; de tilbyder en 'dårlig handel', og det er derfor sjældent at en udenlandsk køber ikke finder bedre tilbud.

Informationsbarriererne i denne model viser sig at have overraskende effekter: Hvis information kunne flyde frit ud til køberne, sådan at de automatisk vidste, hvem der solgte til hvilken pris, så ville der ikke være nogen grund til at lande skulle handle med hinanden! Konkurrence mellem sælgerne ville presse priserne ned til marginalomkostningen, og der ville ikke være nogen grund til at søge udenlandske købere.

Det sidste essay, ”Antidumping with Heterogeneous Firms” bygger det handelspolitiske instrument antidumping ind i en model med heterogene virksomheder. Antidumping er et handelsinstrument, som flere og flere lande har optaget i deres lovgivning i de seneste år; en del udviklingslande er begyndt at bruge det intensivt, hvorimod det indtil 1980erne næsten udelukkende blev brugt af rige lande. Den teoretiske behandling af antidumping har imidlertid ikke fulgt med antidumpings stigende betydning. For at undersøge hvad vi kan lære om antidumping fra modeller med heterogene virksomheder, analyserer jeg det i modellen fra Melitz og Ottaviano (2008).

Modellen fungerer således: Der er to lande i verden, Home og Foreign. Forbrugerne i begge lande efterspørger forskellige varianter af en vare (deres nyttefunktion er en kvadratisk form, og deres efterspørgsel efter hver variant er derfor en lineær funktion af prisen). Hver virksomhed producerer en variant, og virksomheder har forskellige marginalomkostninger for at producere deres variant. For at begynde at producere en variant (starte en virksomhed), skal en fast omkostning betales; efter at have betalt den, lærer virksomheden sin marginalomkostning.

Hvis virksomheden er uheldig, bliver den så uproduktiv at den ikke engang kan sælge noget hvis den sætter sin pris lig sin marginalomkostning. Den vil derfor forlade markedsene lige efter at den indtrådte. Hvis den ikke er så uheldig, vil virksomheden være produktiv nok til at tjene profit på hjemme-

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2 Hvad er antidumping? Hvis virksomheder i et land synes, at udenlandske virksomheder sælger til urimeligt lave priser, kan de klage til en statslig myndighed over at disse virksomheder ’dumper’. Den statslige myndighed vil derefter undersøge, om de udenlandske virksomheder virkelig sætter ”for lave” priser, og hvis den finder dem skyldige, kan den indføre ’antidumping-told’ mod dem, for at beskytte de indenlandske virksomheder mod ”unfair konkurrence”. Adskillige studier har vist, at brugen af antidumping i praksis har meget lidt at gøre med hvad der er skadelig prissætning på nogen økonomisk meningsfuld måde, derfor anførselstegnene.
markedet. Jo lavere en virksomheds marginalomkostning, jo lavere en pris vil den sætte, jo mere vil den sælge, og jo højere profit tjener den. Marginalomkostningen kan være lav nok til at virksomheden kan eksportere. Marginalomkostningen ved at eksportere en vare er $\tau > 1$ gange omkostningen ved at sælge på hjemmemarkedet, og det er derfor kun virksomhederne med lave marginalomkostninger, som kan tjene penge på eksportmarkedet.

Jo flere virksomheder der er på et marked, jo mindre efterspørgsel og jo mindre profit er der til hver virksomhed. Nye virksomheder vil indtræde på markedet indtil profitten bliver drevet ned til ”nul forventet profit”. Det vil sige, før indtræden (og før man kender sin marginalomkostning), vil en virksomhed ikke forvente at få højere profit en den faste omkostning ved at starte en virksomhed.


Når antidumping-myndigheden undersøger hvorvidt virksomheder dumper, sammenligner de virksomhedens pris i hjemlandet med dens eksportpris. De trækker eksportomkostninger fra eksportprisen for at opnå, hvad de kalder ”priser ved fabriksporten”. Denne praksis er lidt besynderlig, for eksporterende virksomheder vil typisk gerne undgå at sende hele eksportomkostningen over på de udenlandske forbrugere, så de kan sælge mere. Dette er også tilfældet i modellen, den optimale pris for eksportører i Home indebærer at de dumper i denne juridiske forstånd. For at undgå at blive anklaget for dumping må virksomheder i Home derfor (suboptimalt) sætte deres eksportpris som $\tau$ gange deres pris på hjemmemarkedet.

Desuden vil visse eksportører i Home, som tjener forholdsvis lidt eksportprofit, holde op med at eksportere. For disse virksomheder er det ikke værd at ofre profit på hjemmemarkedet for at tjene lidt mere på eksportmarkederne, de kan tjene mere på at koncentrere sig om hjemmemarkedet og sætte optimale priser der.

På kort sigt vil denne ændrede prissætning fra Homes eksportører betyde mindre konkurrence i Foreign og mere konkurrence i Home. Forbrugere kan lide konkurrence, og det kan virksomheder ikke, så forbrugere i Home og virksomheder i Foreign er tilfredse, mens forbrugere i Foreign og virksomheder i Home har det værre. På langt sigt vil det imidlertid være anderledes:

Det er nu profitabelt at starte en virksomhed i Foreign: Den reducerede import fra Home betyder at en ny virksomhed i Foreign vil have lav konkurrence og kunne tjene fedt. I Home, på den anden side, er det uattraktivt at starte en virksomhed, for der er meget mindre at tjene på det eneste eksportmarked, Foreign. På langt sigt vil nye virksomheder derfor starte i Foreign, og færre virksomheder vil erstatte de, som forlader Home. Faktisk vil så mange virksomheder indtræde i Foreign at konkurrencen vil stige op over hvad den var uden antidumping, og i Home vil konkurrencen falde til under det tidligere niveau. På langt sigt vil forbrugere i Home derfor tabe fra denne reducerede konkurrence (og fra adgang til færre varianter, fordi der er færre virksomheder), og forbrugerne i Foreign vil vinde.

Et land kan derfor hjælpe sine forbrugere ved at håndhæve antidumping så hårdt at det påvirker hvor mange virksomheder dets marked kan understøtte. Disse gevinster kommer imidlertid på andre landes bekostning. Dette essay er det første, som præsenterer dette resultat. I den virkelige verden ser vi en gruppe ’emerging economies’ (Brasiliens, Indiens, Mexico, Taiwans og Tyrkiets), som bruger antidumping meget, nok til at reducere deres import betydeligt. Heldigvis ser det ikke ud til, at vi er i en situation, hvor alle lande bruger antidumping rigtig meget. Alle gevinster ved at håndhæve antidumping i modellen kommer ved at et land bliver mere attraktivt for virksomheder i forhold til andre lande. Hvis alle håndhævede antidumping intensivt, ville ingen lande blive relativt mere attraktive af det, og alle ville tabe.
1 The Declining Barriers to Foreign Direct Investments and How to See Them

Christian Gormsen

Abstract:
Although Foreign Direct Investments (FDI) are as important to the world economy as exports, the extensive literature on trade costs has no strong parallel for FDI. Data are hard to come by, and many of the barriers to FDI are unobservable. This paper circumvents the problem by inferring the barriers to FDI that are consistent with observed FDI data. I describe the distribution and evolution of these barriers to FDI between pairs of 28 OECD countries from 1985 to 2008. On average, barriers to FDI were halved every 4.8 years. Geography is a key determinant, but GDP per capita also plays a leading role. Decomposing the growth in FDI, I show that it has mainly been driven by lower bilateral barriers (75%), not by economic growth, and that bilateral FDI stocks will tend to crowd each other out, lowering their yearly growth by -3%.

Keywords: Foreign direct investment, economic integration, gravity

JEL-codes: F15, F21, F23
1.1 Introduction

The last few decades have seen a surge in Foreign Direct Investments (FDI). For the average OECD country, inward FDI stocks amounts to 49% of GDP in 2009, up from 14% in 1980. Total sales from the foreign affiliates set up through FDI have nearly twice the value of world exports. Foreign direct investments (FDI) have in sum become as important to the global economy as trade in goods.\(^3\) Despite this large and growing importance, the extensive literature on trade costs has no strong parallel for FDI. The reason for this gap in our knowledge is that many of the costs of doing FDI are difficult to observe or quantify: costs of coordinating with foreign affiliates, complex laws on foreign ownership and cultural barriers, just to name a few.

This paper circumvents the problem of unobservability and is the first to provide data on the barriers to FDI between pairs of OECD countries from 1985 to 2008. Rather than trying to compile data on FDI barriers, I infer what the barriers must be based on observed FDI stocks, by imposing a minimal structure with broad empirical and theoretical support, the gravity equation. I describe the magnitude and variation of FDI barriers across country pairs and their decline over time and examine how much of the barriers to FDI we can account for with previously used proxies like distance or GDP per capita. I show how declining barriers can explain 75% of the growth in FDI from 1985 to 2008, an intriguing contrast to a corresponding study by Jacks, Meissner and Novy (2008) showing that only 33% of the growth in goods trade from 1950 to 2000 is attributable to falling trade costs. As a final contribution, I show that bilateral FDI stocks tend to crowd each other out, on average depressing their yearly growth by 3% (log). This crowding out, which arises because a country only has a limited stock of suitable targets that foreign firms can acquire, raises concerns of misspecification in previous FDI studies.\(^4\)

The inference procedure used to compute the FDI barriers is presented in section 1.2. The inference relies on the gravity equation, one of the strongest

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3 The FDI shares of GDP come from the UNCTAD database. Among others, Mariscal (2010) documents and examines the ratio of affiliate sales to exports.

4 Example: A Spanish firm wishes to acquire a firm in The UK. In 2007, the UK is more open to FDI (and therefore acquisitions) from third-countries than in 1988, and the Spanish firm therefore has a lower chance of actually winning the bid for the UK firm in 2007. In this way, the Spanish stock of FDI in the UK is depressed. If this effect is not controlled for, the FDI-depressing effect of e.g. distance will be over-estimated.
empirical regularities in economics, stating that bilateral stocks of FDI (like trade flows) can be described by a log-linear relationship involving sender and receiver-specific variables (GDP, investment climate etc.), and bilateral variables (distance, whether two countries speak a common language, etc.). The method needs no specific theoretical justification to be valid, but I use the theory developed in Head and Ries (2008) to make the exposition clearer.

The inferred measures, denoted $\phi_{ijt}^{FDI}$, are the pair-wise aggregate barriers that are consistent with how much FDI that actually takes place between the two countries $i$ and $j$ at time $t$. For easier comparison and to account for infinite barriers, I use an inverse measure, giving the attractiveness of owning an affiliate in the other country relative to owning a domestic firm. If $\phi_{ijt}^{FDI} = 0.05$, foreign firms in the pair are on net 0.05 times as attractive to own as domestic firms. As the wording suggests, the bilateral FDI barrier is measured relative to a domestic one; without imposing additional structure, barriers to FDI are inseparable from what I call a domestic bias in firm ownership. Moreover, the measure is symmetric, $\phi_{ijt}^{FDI}$ is the geometric average of country $i$'s barrier to $j$ and $j$'s to $i$. The symmetry, along with data availability, is the reason for constraining the analysis to OECD countries.

The descriptive results in section 1.3.1 show that in 2008, barriers to FDI were lowest between the Netherlands and the UK, $\phi_{ijt}^{FDI} = 0.14$. Between Iceland and South Korea, $\phi_{ijt}^{FDI} = 6.44 \times 10^{-7}$ in 2008, the OECD's highest finite FDI barrier. On average, bilateral barriers to FDI decline by 14% per year (logarithmic rate), so that the barrier is halved every 4.8 years.

Using my inferred barriers as a dependent variable, section 1.4 examines how well observable variables like distance, common language and GDP can explain the barriers to FDI. The $R^2$ of such a regression is 0.84, but the fit drops markedly without country fixed effects. The estimated country fixed effects suggest that a country has lower domestic bias in firm ownership (or equivalently, lower average barriers to FDI), if it has low corporate taxes, high GDP per capita or English as main language.

As a compliment to the bilateral FDI barriers, section 1.5 presents an inferred measure of a country's aggregate inward barriers to FDI. Building on Head and Ries (2008), this measure, denoted $\Phi_{it}^{FDI}$, can be interpreted as how

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5 In the references cited at the end of the introduction, the overall fit ($R^2$) of a gravity equation for FDI is between 0.6 and 0.9.
difficult foreign firm ownership is relative to domestic firm ownership in country \( i \). It is the dramatic decline in this measure that suggest that FDI crowding out is an issue that must be accounted for; in a gravity equation with bilateral FDI stocks, a possibility is country-year fixed effects or country-specific trends. A decomposition in section 1.6 reveals that on average, the 41% yearly log-growth in bilateral FDI stocks consists of a 31% decline in FDI barriers, a 13% growth in domestic capital, and a -3% crowding-out effect.

The inference method, which this paper is the first to apply to FDI, has frequently been used to measure trade costs. Inferred trade costs were first introduced by Head and Ries (2001), subsequent applications include: Describing the distribution and evolution of trade costs (Eaton and Kortum (2005), Novy (2008), Jacks, Meissner, and Novy (2008) and McGowan and Milner (2010)) and calibrating models in economic geography (Head and Mayer (2004), Combes, Mayer and Thisse (2008)) and in international trade (Eaton, Kortum, Neiman and Romalis (2010)). Costs of FDI are arguably even harder to observe than trade costs, so indirect measurement is likely to be as enlightening as it has been for trade in goods.

Burstein and Monge-Naranjo (2009) carries out an inference procedure similar in spirit to the present paper, in order to assess the barriers to the inflow of know-how in developing countries and the gains from removing them. The structure imposed by that paper is more restrictive, but it enables the authors to derive welfare implications from a measure that has strong similarities to \( \Phi^{FDI}_a \) (aggregate inward FDI barriers) derived below.

Multiple studies have used gravity-type regressions to look for determinants of bilateral FDI. Examples include Eaton and Tamura's (1994) study of factor endowments and region-specific effects, Wei (2000)'s analysis of corruption, information proxies as in Loungani, Mody, Razin and Sadka (2003), Mutti and Grubert's (2005) study of the effects of taxes and wages, and institutional factors in Bénassy-Quéré, Coupet and Mayer (2007). Distance, common borders, common languages and past colonial ties are included throughout the literature; Head and Ries (2008) argue that distance proxies for monitoring costs and Crozet, Mayer and Mucchielli (2004) show how firms often set up affiliates just on the other side of a common border.

### 1.2 Inferring the Barriers to FDI

The method of inferring bilateral barriers relies on the gravity equation, one of the most well-established empirical regularities in economics. The inference
procedure does not rely on any particular theory for why the gravity equation holds for FDI, but with a theoretical framework the mechanisms and properties of the openness measures are more clearly exposed. Subsection 1.2.1 describes the theoretical framework and subsection 1.2.2 describes how the inference procedure is taken to the data.

1.2.1 A Theoretical Framework

Consider the gravity equation for FDI derived in Head and Ries (2008). Their underlying model concerns mergers and acquisitions (M&A), which is the bulk of FDI flows, especially among developed countries. A firm in country $i$ wishes to acquire a firm in country $j$, it makes a bid for the firm, and if the offer is good enough, the firm in $i$ purchases (or merges with) the firm in $j$. In the aggregate, a gravity equation emerges: The predicted stock of FDI that firms in $i$ own in $j$, $F_{ij}$, is

$$ F_{ij} = \exp\left(\frac{\mu_i}{\sigma - D_{ij}\theta}\right) s_i^m K_j B_j^{-1} $$

(1.1)

$\mu_i$ is the average valuation that firms in country $i$ put on any asset, a higher average valuation (for instance if the country is rich) means that firms will be willing to pay more for all assets, increasing their expected stock of FDI in any country. The variance of the valuations is denoted by $\sigma$. These valuations are affected by $D_{ij}\theta$, a vector of bilateral factors $D_{ij}$ weighted with their coefficients $\theta$. Bilateral factors include both observables such as distance and language barriers, and unobservables like cultural barriers or monitoring costs.

If more of the world's firms are located in $i$, $i$ will also win bids more often and own more assets in any country, this effect is captured by $s_i^m$, the share of the world's firms located in $i$. $K_j$ is the capital stock in $j$, all else being equal, the more firms there are to buy in $j$, the higher will be the (absolute) value of firms owned by foreigners. The term $B_j^{-1}$, "bidder competition", captures third country effects: If firms from other countries bid intensively for firms in $j$, firms in $i$ will have a harder time winning the bids, lowering $F_{ij}$.

Bidder competition is the FDI counterpart to inward multilateral resistance introduced by Anderson and van Wincoop (2003) for trade in goods. It is an aggregate of country $j$'s barriers: $B_j = \sum_{h=1}^{M} \exp\left(\frac{\mu_h}{\sigma - D_{jh}\theta}\right) s_h^m$.

The method of inferring the bilateral factors $D_{ij}\theta$ from observed stocks of FDI ($F_{ij}$) relies on the fact that the theory also has a prediction of country $i$'s
"stock of FDI in itself". That is, how much of the capital stock is still on domestic hands, after both foreign and domestic firms have made their bids for firms in \(i\). Domestically owned capital stock, \(F_{ii}\), will be given by

\[
F_{ii} = \exp\left(\frac{\mu_i}{\sigma - D_j \theta}\right) K_j^{-1}
\]  

(1.2)

The same factors affect \(F_{ii}\) and \(F_{ij}\). There might be country-specific reasons why firms in \(i\) place particular value on domestic assets, captured by \(D_{ii} \theta\). These "home ownership biases" turn out to be quantitatively important.

Consider the measure

\[
\phi_{ij}^{FDI} = \frac{F_{ij}}{F_{ii} F_{jj}}
\]

The domestically and foreign-owned capital stocks, are determined by the same variables, which all enter multiplicatively. The index therefore simplifies to

\[
\phi_{ij}^{FDI} = \frac{\exp(D_{ii} \theta) \exp(D_{jj} \theta)}{\exp(D_{ij} \theta) \exp(D_{ji} \theta)}
\]

With the theoretical framework, the key properties of the inferred openness measure become apparent. First of all, country-specific variables have cancelled out, and we are left with the bilateral factors that make up the net barriers between \(i\) and \(j\). More precisely, \(\phi_{ij}^{FDI}\) measures the inverse of the net cost of holding foreign capital between country \(i\) and country \(j\). If \(\phi_{ij}^{FDI} = 0.10\), then residents in country \(i\) consider owning firms in country \(j\) 0.10 times as attractive as owning firms at home, and vice versa. To express the number as a barrier, take the inverse, it is on net (0.10)^{-1}=10 times more costly to own firms abroad in the pair than owning firms at home. (The inverse measure is chosen in line with most work on inferred trade barriers and facilitates comparison across country pairs).

The cancelling out of country-specific factors is the basic idea behind the inference method. The method works whenever the country-specific factors enter multiplicatively, as they do in a gravity equation. The validity of the procedure relies on the empirical fit of the gravity equation for FDI; whether the particular theory used here is valid or not is not crucial.
A second property of the inferred measure is suggested by the phrasing in the example: an international barrier is always measured relative to a domestic one. Bilateral barriers cannot (and perhaps should not) be distinguished from a home bias in firm ownership ($D_{ii}\theta$ and $D_{ij}\theta$). As an example, Poland turns out to have high barriers to FDI, or high home bias. Reasons may be that Polish capital is unattractive to foreigners or that Polish firms face liquidity constraints when seeking to set up or acquire firms abroad. This paper considers these impediments part of the barrier to FDI. Nevertheless, as outlined below, aggregate domestic bias (outward and inward combined) can be separated from purely bilateral barriers by regressing $\phi^{FDI}_{ijt}$ on country fixed effects.

A third and more problematic property is that the inferred openness between $i$ and $j$, will be the geometric mean of how open country $i$ is to country $j$ and how open country $j$ is to country $i$. If the two countries have similar openness the average is a good measure, it will be less informative for country pairs with asymmetric barriers. That, along with data limitations, is the reason for restricting the current study to OECD countries.

Fourth, $\phi^{FDI}_{ijt}$ measures aggregate openness; all bilateral costs or benefits of FDI, whether observable or not, are included and weighted with their coefficients:

$$D_{ij}\theta = \theta_1d_{1ij} + \theta_2d_{2ij} + \theta_3d_{3ij} + \ldots$$

The advantage of inferring the FDI costs rather than compiling observable costs are clear: It gives an easy to compute measure of the overall net openness to FDI, which is what matters for investment decisions (a tautological statement, because the measure is calculated from actual investments). It includes the impact of unobservable barriers or benefits. The measure is comparable across country pairs and over time.

Because the inferred barrier is an aggregate, it does not have a meaningful counterfactual. We can compare the aggregate barrier to FDI between Portugal and Spain to the one between Australia and New Zealand, we can use regression analysis to examine how much distance can explain of the aggregate barriers, but it does not make sense to ask what happens if we remove the aggregate barrier to FDI. The static model in the theoretical exposition conceals a fifth property of the inferred barriers: $\phi^{FDI}_{ijt}$ is calculated on the basis of FDI stocks, and if these stocks take time to adjust to changes in FDI barriers, $\phi^{FDI}_{ijt}$ will measure the
barrier with a lag. It is unclear, however, why FDI stocks should take time to adjust; annual fluctuations in FDI stocks can be very large as investments are typically one-time events.

1.2.2 Inferring a country's inward barriers to FDI

The theoretical model in Head and Ries (2008) suggests a compliment to the bilateral measures, a country's aggregate inward barriers to FDI. Consider the fraction of a country's total capital stock which is on domestic hands:

\[
\Phi_{i,FDI} = \frac{F_{ii}}{K_i}
\]

The share of a country's capital which is domestically owned is a quite intuitive way of measuring a country's inward FDI barriers. If capital is acquired by foreigners through acquisitions, \( F_{ii} \) falls, if new capital is constructed through greenfield FDI, \( K_i \) rises, with \( F_{ii} \) unchanged.

The measure also has a theoretical interpretation. Using (1.2) above, \( \Phi_{i,FDI} \) can be written as

\[
\Phi_{i,FDI} = \frac{\exp\left(\mu_i / \sigma - D_{ii}\theta\right)s_i^m}{\sum_{k=1}^{M} \exp\left(\mu_k / \sigma - D_{ik}\theta\right)s_k^m} \cdot b_{ii} \cdot B_i, \quad (1.3)
\]

where \( b_{ii} \) summarizes the strength of domestic bids, and \( B_i \) is the "bidder competition". \( \Phi_{i,FDI} \in [0,1] \) is therefore a measure of the relative strength of domestic bidders, the higher \( \Phi_{i,FDI} \) the higher their advantage over foreign bidders when wanting to acquire domestic firms. If a country has high inward barriers to FDI (\( D_{ii}\theta < D_{ih}\theta \neq i \)), domestic bidders will be favored. In this manner, \( \Phi_{i,FDI} \) is an aggregate of the country's barriers to FDI. The measure is not entirely neutral to size or wealth, however. If a country is rich (implying higher average valuations, \( \mu_i \)) or has relatively many firms (high \( s_i^m \)), \( \Phi_{i,FDI} \) will increase as well.6

6 The way the total capital measure is constructed, Greenfield FDI is counted as an increase in \( K_i \). With this construction, a country with a large inflow of Greenfield FDI is classified as having fiercer bidder competition. The rationale is that with the addition of new foreign-owned capital from a given country, each of the inward bilateral FDI stocks from other countries make up a lower share of total capital.
1.2.3 Implementing the Inference Procedure

Data on bilateral FDI stocks, $F_{ji}$, are readily available, $F_{ii}$ is more problematic. The precision of inferred openness depends on how well a country's investment stock in itself, $F_{ii}$, is measured. The model of Head and Ries (2008) suggests computing a country's FDI with itself as a residual: the amount of capital in country $i$, which is still on domestic hands after all foreign firms have acquired firms in $i$. Following Head and Ries (2008) and Burstein and Monge-Naranjo (2009), I calculate a measure of a country's capital stock, $K_i$, in the standard way, by compiling investments from the national accounts using a perpetual inventory method. Investment data is taken from the OECD database (gross fixed capital formation); I subtract investments in dwellings to get rid of the most obvious non-business investments.

The depreciation rate is set to $d = 0.07$, and as an initial guess of a country's capital stock for the first year, I use an inverted production function: $K_{i0} = (Pop_{i0})^{1.022} (Y_{i0}/Pop_{i0})^{0.964}$, where $Y_{i0}$ is GDP at the date from which investment data is available. The guess is based on Head and Ries (2008)'s finding that 93% of the variation in their measure of capital stock can be explained with a log-log regression yielding the relation above. I use real investments and then inflate the capital measures each year, using the ratio of nominal to real investments, to have measures comparable to the nominal FDI stocks.

Because foreign firms have merged with or acquired firms in country $i$, some of this capital stock will not be domestically owned. To get to domestically owned capital, we must subtract the stock of inward mergers and acquisitions (M&A) in $i$; if a share $\eta_{iM&A}$ of the stock of inward FDI in $i$ come in the form of mergers and acquisitions, we can compute $F_{ii}$ as:

$$F_{ii} = \tilde{K}_i - \eta_{iM&A} \sum_{j \neq i} F_{ji}$$

As an estimate of $\eta_{iM&A}$ I use the average share of M&A in FDI inflows to country $i$ from 1988 to 2006, computed with FDI and M&A flow data from the UNCTAD database.

The total capital stock in $i$, disregarding ownership and including what comes in as greenfield FDI is given by

$$K_i = F_{ii} + \sum_{j \neq i} F_{ji}.$$
It is this total capital measure that is used to infer a country's overall barriers to inward FDI defined in (1.3).

1.3 Data and Descriptive Results

Data on bilateral FDI stocks $F_{ij}$ are taken from the OECD online database. The time period is 1985-2008 with some holes due to lack of data. To maximize data coverage I use both inward and outward FDI data. Due to the difficulties of dealing with countries with asymmetric barriers, the analysis is confined to OECD members, data for Belgium, Luxembourg, Chile, Slovenia, Israel and Estonia are unavailable. The sample consists of pairs of these 28 countries: Australia, Austria, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea (South), Mexico, The Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, UK, USA. Available data allow the construction of $\phi_{ij}$ for 324 pairs with varying time series length for a total of 4727 observations (out of 9072 possible observations for 378 possible pairs).

Domestic investments used to construct domestic capitals also come from the OECD database, "gross domestic capital formation" minus the subcategory...
"dwellings", as do population and GDP per capita data used to construct the initial capital guess. GDP per capita is in US$ constant prices, constant PPPs (2000 is the OECD base year). The UNCTAD M&A and total FDI inflow data from 1987 to 2006 are available online.

1.3.1 Describing FDI Barriers Between Countries and over Time

Figure 1 plots $\phi_{ijt}^{FDI}$ for 7 country pairs. In 1985, Canada-USA was the most integrated pair in the world, owning foreign affiliates in the other country was $\phi_{Can,US,85}^{FDI} = 0.023$ as attractive as owning domestic firms. As seen, however, FDI barriers have declined more quickly for several other pairs. By 1995 both Norway-Sweden and The Netherlands-UK were more integrated, with the latter pair setting the world record for low FDI barriers in 2007: $\phi_{NL,UK,07}^{FDI} = 0.227$.

Figure 2 gives an overview of the distribution of $\phi_{ijt}^{FDI}$ in 1988 and 2006 on a common log scale; black bars represent pairs sampled in both years. The distributions have their masses in the middle and upper end, with a long tail of pairs with very high barriers. In 2006 there are also 41 observed zero values, corresponding to a barrier so large that no investments are worthwhile.

**Figure 2:** Cross-sections of $\phi_{ijt}^{FDI}$

<table>
<thead>
<tr>
<th>Year</th>
<th>FDI Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1988</td>
<td><img src="image" alt="Cross-section of FDI in 1988" /></td>
</tr>
<tr>
<td>2006</td>
<td><img src="image" alt="Cross-section of FDI in 2006" /></td>
</tr>
</tbody>
</table>

The upper bar shows the cross-section of $\phi_{ij}^{FDI}$ in 1988, the lower the cross-section in 2006, the axis is common. Grey observations in 2006 are country pairs for which there were no data in 1988.

It is hardly surprising that there are "improbable" pairs with very high barriers, (1988's lowest $\phi_{ijt}^{FDI}$ is Austria-Finland and 2006's is Iceland-Korea), but it is noteworthy that these pairs are the exception in the OECD.

Figure 3 plots the second bar of figure 2, $\phi_{ijt}^{FDI}$ in 2006, against bilateral distance.
A negative relationship can be glimpsed, but it appears more clearly with the separation into black- and blue-colored pairs (+ and o symbol, respectively), the latter involve at least one country with relatively low GDP per capita. As the regression analysis in section 1.4 below will confirm, GDP per capita is an important determinant of the aggregate barriers to FDI.

Let us now turn to how FDI barriers evolve over time. Figure 4 helps us answer the following questions: How much do FDI barriers decline across country pairs? Does the decline vary with countries' income? Which pairs integrate the fastest, those that are the least or the most integrated to begin with?
The annualized log growth rates of $\phi_{ijt}$ are displayed on the y-axis of Figure 4, a type of figure often used for convergence analysis. The x-axis shows the value of $\phi_{ijt}$ for the first year for which data is available for the $ij$-pair, (e.g. 1985 for Canada-USA and 2000 for Slovakia-Spain). Country pairs are divided into 3 groups, again according to the countries' GDP per capita: the least wealthy are orange ("emerging countries"), countries with intermediate wealth and relatively fast GDP growth are blue ("catch-up countries"), and

"o": pairs with a poorer country
"x": pairs with a middle-income country
"+": pairs of wealthy countries
pairs of the remaining countries are black (indicating that they are wealthy throughout the sample period, "rich countries").

If pairwise FDI barriers converge towards the same level, there should be a downward-sloping relationship in Figure 3, if there is divergence (meaning that already integrated countries keep integrating faster than the rest), the relationship should be positive. If anything, the graph indicates convergence (the correlation between initial levels and growth rates is -0.21), but the dominant picture is one of more variance for lower initial levels of $\phi_{ijt}^{FDI}$, it is easier to have large variations in growth rates for low initial levels. Pairs with "catch-up" and "emerging" countries have seen larger declines in FDI barriers than the rich countries, though, as is seen when comparing the marginal distributions of growth rates or looking at the summary statistics in Table 1.\(^7\)

<table>
<thead>
<tr>
<th>Table 1: Summary statistics of log growth rates in $\phi_{ijt}^{FDI}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
</tr>
<tr>
<td>-------------------</td>
</tr>
<tr>
<td>Rich countries (black +)</td>
</tr>
<tr>
<td>Catch-up countries (blue o)</td>
</tr>
<tr>
<td>Emerging countries (orange x)</td>
</tr>
</tbody>
</table>

Half-life is the average time it takes for FDI barriers to fall by 50%.
Colors and symbols refer to Figure 4.

1.4 Observable and Unobservable FDI Barriers

The descriptive results above support the conclusion from the existing empirical literature on FDI that distance, languages, and GDP are important determinants of the barriers to FDI. On the other hand, it is also clear that these variables do not tell the entire story, they can hardly explain the growth in FDI or curious outliers like Denmark-Portugal. This section examines how much of the barriers to FDI we can relate to observable barriers or proxies emphasized by the previous literature. First, in section 1.4.1, a presentation of the estimation strategy and relevant variables, results follow in section 1.4.2. Home bias in firm ownership receives particular attention in section 1.4.3, which also discusses unexplained FDI barriers in general.

\(^7\) Although the distributions differ, the differences between the means are not statistically significant.
1.4.1 Estimation Strategy

Maintaining the assumption that the component of FDI barriers enter multiplicatively (in line with the derivations in section 1.2.1 and with estimation of gravity equations in general),

\[
\phi_{ij}^{FDI} = \frac{\exp(D_{ii}\theta)\exp(D_{jj}\theta)}{\exp(D_{jj}\theta)\exp(D_{ii}\theta)},
\]

I split the bilateral FDI openness into observable and unobservable variables:

\[
\phi_{ij}^{FDI} = \text{dist}_{ij}^{\alpha} \exp(\theta_2 \text{neigh}_{ij}) \exp(\theta_2 \text{lang}_{ij}) \exp(\theta_3 \text{neigh}_{ij}) \\
\times (GDP_{it} \cdot GDP_{jt})^{\theta_t} \exp(\gamma_t) \eta_{ijt}.
\] (1.4)

Based on previous studies (see the introduction), I use the following observable variables: dist_{ij}, the great arc distance in kilometers between the capitals in country i and country j; neigh_{ij}, lang_{ij} and colony_{ij} are dummy variables indicating, respectively, whether countries i and j are neighbors (sharing a border or having only a small body of water between them), share a main language, and whether the two countries have been one in the past or whether one was a colony of the other. These variables are taken from the CEPII database, note that they are all symmetric, x_{ij} = x_{ji}. Countries i and j’s GDP, GDP_{it} and GDP_{jt}, are taken from the OECD database and measured at constant PPPs and prices (base year 2000).

Because \phi_{ij}^{FDI} is symmetric \phi_{ij}^{FDI} = \phi_{ji}^{FDI}, we would expect i and j's per capita GDP and populations to enter with the same coefficient, as imposed. In some specifications, I split GDPs into per capita GDPs and populations at their 1985 levels, both are taken from the OECD database. Year dummies \gamma_t capture the overall positive trend in \phi_{ij}^{FDI}. The "non-trend" unobservable barriers, \eta_{ijt}, are lumped together in an error term.

A widespread econometric approach to estimating a relationship like (1.4) is to take logs on both sides and run a linear regression. In an influential recent paper Santos Silva and Tenreyro (2006) lay out the extreme regularity conditions that this procedure requires to be valid: All conditional moments of \eta_{ijt} must be independent of the explanatory variables, otherwise the estimates from the log-log model will not be consistent estimates of the parameters of
the multiplicative relationship above. Of particular concern is heteroskedasticity in $\eta_{ijt}$.

Examinations of actual values vs. fitted values from log-log regressions make it clear that these regularity conditions are not met when estimating (1.4) in log-log. I therefore use the alternative estimation procedure that Santos Silva and Tenreyro (2006) suggest, Poisson pseudo-maximum-likelihood (PPML) using (1.4) in its multiplicative form.

The domestic biases in capital ownership, $D_i, D_j$, are part of the inferred barriers to FDI. As argued above, distinguishing a high domestic bias in capital holdings from a high average barrier to FDI is conceptually difficult and practically impossible without imposing a lot of structure. I treat domestic biases in two ways, with different implications for the identification of the estimated coefficients. Table 2 in the next subsection present the results.

It could be that a country's domestic bias (or average FDI barrier) is well explained by its geography, how widespread its main languages are and how wealthy and large it is. That is the assumption behind specifications (1) and (3) in table 2. In specifications (2) and (4), the error term is specified as $\eta_{ijt} = \exp(c_i)\exp(c_j)v_{ijt}$, $c_i$ and $c_j$ being country dummies that cancel out the domestic biases. With country fixed effects included in this manner, the estimation identifies parameters using only the distribution of bilateral FDI openness, conditional on each country's average bilateral FDI openness.
1.4.2 Observable FDI Barriers

Table 2. The components of bilateral barriers to FDI. Dependent variable: $\phi_{ij}^{FDI}$

<table>
<thead>
<tr>
<th>Specification</th>
<th>(1)</th>
<th>(2, FE)</th>
<th>(3)</th>
<th>(4, FE)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>coeff.</td>
<td>%-effect</td>
<td>coeff.</td>
<td>%-effect</td>
</tr>
<tr>
<td></td>
<td>(std. error)</td>
<td>[z-stat]</td>
<td>(std. error)</td>
<td>[z-stat]</td>
</tr>
<tr>
<td>Distance$_{ij}$</td>
<td>-0.69</td>
<td>[-21.8]</td>
<td>-0.47</td>
<td>[-18.5]</td>
</tr>
<tr>
<td>(0.03)$^a$</td>
<td></td>
<td></td>
<td>(0.03)$^a$</td>
<td></td>
</tr>
<tr>
<td>Neighbors$_{ij}$ (0,1)</td>
<td>-0.07</td>
<td>[-0.8]</td>
<td>0.40</td>
<td>[49%]</td>
</tr>
<tr>
<td>(0.09)</td>
<td></td>
<td></td>
<td>(0.04)$^a$</td>
<td>[10.6]</td>
</tr>
<tr>
<td>Common language$_{ij}$ (0,1)</td>
<td>1.16</td>
<td>[218%]</td>
<td>0.49</td>
<td>[63%]</td>
</tr>
<tr>
<td>(0.08)$^a$</td>
<td>[14.2]</td>
<td></td>
<td>(0.06)$^a$</td>
<td>[8.8]</td>
</tr>
<tr>
<td>Colonial past$_{ij}$ (0,1)</td>
<td>0.29</td>
<td>[34%]</td>
<td>1.21</td>
<td>[235%]</td>
</tr>
<tr>
<td>(0.11)$^a$</td>
<td>[2.6]</td>
<td></td>
<td>(0.07)$^a$</td>
<td>[17.1]</td>
</tr>
<tr>
<td>GDP$<em>{it}$xGDP$</em>{jt}$</td>
<td>0.37</td>
<td>[23.2]</td>
<td>0.44</td>
<td>[3.6]</td>
</tr>
<tr>
<td>(Per capita GDP$<em>{it}$) x (Per capita GDP$</em>{jt}$)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Population in 1985$_i$) x (Population in 1985$_j$)</td>
<td>0.31</td>
<td>[21.8]</td>
<td>0.41</td>
<td>[12.9]</td>
</tr>
<tr>
<td>(Population in 1985$_i$) x (Population in 1985$_j$)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year dummies ($\gamma_t$)</td>
<td>Yes [sum 74.7]</td>
<td>Yes [sum 101.8]</td>
<td>Yes [sum 46.6]</td>
<td>Yes [sum 79.5]</td>
</tr>
<tr>
<td>Country fixed effects ($c_i$ and $c_j$)</td>
<td>No</td>
<td>Yes [sum 277.6]</td>
<td>No</td>
<td>Yes [sum 494.7]</td>
</tr>
</tbody>
</table>

4727 observations. %-effect: Percentage change in inverse FDI barrier when independent variable goes from 0 to 1, calculated as exp(-$b$) – 1. Estimation method: Poisson pseudo-maximum-likelihood, estimated coefficients are elasticities. Specification (4) is preferred. Robust standard errors in parentheses. Square parentheses t-statistics, corresponding to the explanatory variables' importance in explaining the variation in the dependent variable $R^2$s are computed as the correlation between the dependent variable and the fitted values. $^a$: significant at 1% level.

Specification (4) is my preferred specification. The fit of the regression is dramatically improved when controlling for countries' home bias in firm ownership (the $R^2$ is computed as $corr(\phi_{ij}^{FDI}, \phi_{ij}^{FDI})^2$). Distance increases the barriers to FDI; although an elasticity of 0.47 is perhaps not dramatically
large, the explanatory power of distance is consistently large across specifications. On top of the distance effect, two countries that are neighbors have half the FDI barrier of other pairs; when country-specific spurs and barriers to FDI are cancelled out, Crozet, Mayer and Mucchielli (2004)'s discovery that affiliates tend to cluster just across the border is quantitatively quite important.

A very large reduction in FDI barriers comes with a past as a common country, the effect seems to be highly dependent on controlling for home bias. Including the Austro-Hungarian empire and the Nordic countries, only 16 country pairs have colonial or common country pasts in the OECD, so it is remarkable that the variable is so important in explaining $\phi_{ijt}^{FDI}$. The common language coefficient changes dramatically across specifications, but an intuitive story fits the pattern. Controlling for population sizes but not for country fixed effects, gives the lowest coefficient. A country with a widespread language has lower domestic bias in firm ownership.

The idea behind separating GDP into per capita GDP and population is that they are likely to have distinct effects. A large market may allow more firms to recoup fixed costs of owning an affiliate there, as emphasized in the literature on proximity-concentration trade-offs, see for instance Melitz, Helpman and Yeaple (2004); the population variable tries to capture this idea, although GDP per capita may still contain market size effects. In order to keep out effects correlated with population growth, populations are kept fixed at their 1985 level. GDP per capita may also relate to the quality of a country's institutions, lowering the costs of having an affiliate there, see Wei (2000) and Bénassy-Quéré, Coupet and Mayer (2007). Also, firms in rich countries may simply own assets that are more attractive to foreigners, and firms in poorer countries may have problems raising enough funds for international acquisitions or greenfield investments. As a counterbalancing effect, wages are also higher in rich countries, increasing the costs (both marginal and fixed) of serving them through local affiliates.

Controlling for their effect on home bias, a subject which will be treated shortly, per capita GDP and population remain noteworthy determinants of the distribution of FDI barriers. Given their average barrier, countries tend to have 1.1% lower FDI barriers towards wealthier countries, the negative wealth effects from higher wages appear to be outweighed. And a larger market is more attractive, something which traditional gravity-based studies of FDI determinants have a harder time identifying, because larger countries also "mechanically" attract more FDI to satisfy their greater demand.
In addition to the lower fit, the estimated coefficients also differ without country fixed effects. With some caution, because cross-coefficient effects may play a role, we can learn about the home biases by examining these changes. In addition to the language effect described just above, the most striking difference is in GDP per capita. Its large z-statistic and high positive elasticity in specification (3) suggest that it is an important determinant of home bias. Population also has a much higher z-statistic, but the coefficient is slightly lower without fixed effects. It is plausible that a large market reduces domestic bias, but that the effect comes from adding up the effects that specification (4) identifies: no matter the size of their origin country, firms prefer investing in a foreign market if it is large, large markets therefore have their average barriers to FDI reduced. Note also that the fit of specification (3) with separate wealth and market size effects is much higher than that of specification (1).

The stronger distance effects in specification (1) and (3) might pick up a remoteness effect: A country like Japan could suffer an additional increase in its FDI barriers, because its isolated location, far from most OECD countries, makes it an unattractive FDI partner, adding to the already large distance-related barriers with each individual country. The coefficient change may also reflect the vanished neighbor effect.

The way FDI is constructed, a concern may be that a positive shock to domestic investments in a given year, without a corresponding increased inflow of FDI, will translate into higher FDI barriers with all the country's partners in that year. The inference procedure considers this shock to be part of the FDI barrier, but an obvious alternative way of dealing with the problem is to replace the country dummies with country-year dummies, i.e. to specify the error term and time trend as exp(γt)ηijt = exp(ζij)ζijt. Unfortunately, the Poisson estimation will not converge with the larger set of dummies. In the appendix 1, I do the log-log regression with country-year dummies also. The estimated coefficients do not change, except a dramatic increase in the population coefficient, although the variable has little explanatory power.

1.4.3 Pair-Specific FDI barriers

The previous subsection established that the main determinants of the inferred barriers to FDI were country-specific factors; adding country fixed effects greatly improved the fit of the estimations in table 1. The estimated country fixed effects from the preferred specification (4) in table 1 can be used to
compute how much each country's average FDI barrier deviates from its expected value of 1. The results are reported in table 2, and they allow an assessment of how the variables that the previous subsection suggested were determinants of the country-specific factors (per capita GDP, a country's geographical position and the prevalence of its language) aggregate up, and of what other factors may play a role:  

<table>
<thead>
<tr>
<th>Country</th>
<th>Deviation from Expected Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Netherlands</td>
<td>-84%</td>
</tr>
<tr>
<td>Ireland</td>
<td>-76%</td>
</tr>
<tr>
<td>Switzerland</td>
<td>-74%</td>
</tr>
<tr>
<td>New Zealand</td>
<td>-74%</td>
</tr>
<tr>
<td>Sweden</td>
<td>-65%</td>
</tr>
<tr>
<td>Australia</td>
<td>-60%</td>
</tr>
<tr>
<td>Norway</td>
<td>-54%</td>
</tr>
<tr>
<td>Ireland</td>
<td>-53%</td>
</tr>
<tr>
<td>UK</td>
<td>-45%</td>
</tr>
<tr>
<td>Germany</td>
<td>-3%</td>
</tr>
<tr>
<td>Mexico</td>
<td>193%</td>
</tr>
<tr>
<td>Ireland</td>
<td>-76%</td>
</tr>
<tr>
<td>USA</td>
<td>-45%</td>
</tr>
<tr>
<td>Spain</td>
<td>2%</td>
</tr>
<tr>
<td>Poland</td>
<td>225%</td>
</tr>
<tr>
<td>Switzerland</td>
<td>-39%</td>
</tr>
<tr>
<td>Denmark</td>
<td>-39%</td>
</tr>
<tr>
<td>Italy</td>
<td>17%</td>
</tr>
<tr>
<td>Turkey</td>
<td>288%</td>
</tr>
<tr>
<td>New Zealand</td>
<td>-37%</td>
</tr>
<tr>
<td>France</td>
<td>-37%</td>
</tr>
<tr>
<td>Hungary</td>
<td>64%</td>
</tr>
<tr>
<td>Czech Rep.</td>
<td>304%</td>
</tr>
<tr>
<td>Sweden</td>
<td>-27%</td>
</tr>
<tr>
<td>Portugal</td>
<td>-27%</td>
</tr>
<tr>
<td>Austria</td>
<td>102%</td>
</tr>
<tr>
<td>Slovak Rep.</td>
<td>391%</td>
</tr>
<tr>
<td>Australia</td>
<td>-16%</td>
</tr>
<tr>
<td>Canada</td>
<td>-16%</td>
</tr>
<tr>
<td>Finland</td>
<td>107%</td>
</tr>
<tr>
<td>Korea</td>
<td>488%</td>
</tr>
<tr>
<td>Norway</td>
<td>-8%</td>
</tr>
<tr>
<td>Iceland</td>
<td>-8%</td>
</tr>
<tr>
<td>Japan</td>
<td>115%</td>
</tr>
<tr>
<td>Greece</td>
<td>541%</td>
</tr>
</tbody>
</table>

Deviations calculated using the country fixed effects in table 1, specification 4. A country's expected value of FDI barriers (both inward and outward) is based on its geographical position, relative wealth and population, and whether it shares a language or a colonial past with other countries.

The three countries with the lowest barriers to FDI are all known for their lenient corporate taxes, having the lowest corporate taxes seems to be an important attractor of FDI. Increasing abilities for companies to arbitrage tax payments across countries may drive part of the decline in aggregate FDI barriers.

GDP per capita does seem to be an important determinant of the percentage deviations, but it is far from the only factor. The relatively high ranks for

---

8 Depending on the country-pair observation, a country may enter as i or j in the regressions. Because $\varphi_{ij}^{\text{crit}}$ is symmetric, the distinction is arbitrary, but it gives rise to two estimated country fixed effects for each country h, call these, with a slight abuse of notation, $c_i h$ and $c_j h$. These estimates should be mean-corrected (because the estimation may arbitrarily attribute the regression's constant to either i-dummies, j-dummies, year dummies or the constant term), and weighted according to how often a country appears as i or j in a pair. Country h's total fixed effect, $FE_h$, is calculated as $FE_h = a_h (c_i h - \bar{c}_i) + (1 - a_h) (c_j h - \bar{c}_j)$, where $a_h$ weights how frequently country h appears as i, and where $\bar{c}_i$ and $\bar{c}_j$ are the means across all $c_i h$ and $c_j h$ estimates, respectively. The percentage deviation is then calculated as $\exp(-FE_h) - 1$. 

1—20
Portugal and Spain might relate to their low wages (and hence low GDP per capita). English-speaking countries are well represented at the top; it seems that the benefits of speaking a global language compensates for a remote location for Australia and New Zealand. Remoteness hits much harder on Japan and South Korea, the low ranks of Finland and Greece could also be due to their location at the "corners" of Europe.

1.5 Increasing Crowding Out of FDI

A disadvantage of the analysis so far has been that the inference procedure for bilateral barriers to FDI lumps together inward and outward barriers. As outlined in section 1.2.2, a complimentary measure infers a country's overall inward barriers to FDI, it is calculated as the fraction of a country's capital stock, which is still domestically owned: \( \Phi_{it}^{FDI} = F_{it} / K_{it} \).

Figure 5 depicts \( \Phi_{it}^{FDI} \) for the sampled countries.

The overall picture is one of significant declines in \( \Phi_{it}^{FDI} \), the advantage that domestic buyers have over foreign buyers has fallen. There are exceptions,
however: Inward barriers in Japan, Korea and Finland remain high, and Ireland has no downward tendency in its already low aggregate barrier.

An important implication follows from Figure 5. The model of Head and Ries (2008) points out the necessity of correcting for country differences in bidder competition when estimating gravity equations for bilateral FDI stocks. Otherwise, regressions will suffer from omitted variables bias, as higher overall openness will tend to depress bilateral FDI stocks. Figure 6 shows that the solution applied by Head and Ries (2008), country fixed effects, is insufficient: $\Phi^{FDI}_{it}$, which is closely related to bidder competition, changes, even over relatively short time periods, and the rates of change clearly differ across countries. As we shall see in the next section, the growth in FDI stocks has been notably lower due to increased bidder competition.

The problem is similar to the one pointed out in Novy (2008): When estimating gravity equations for trade in goods, it is necessary to control for changes in multilateral resistance. For FDI, the problem is accentuated, since the reductions in $\Phi_{it}^{FDI}$ are proportionally larger than the changes in inferred multilateral resistance reported by a similar inference procedure in Novy (2008) The debate in the trade literature on how to correct for time-variant multilateral resistance has not yet reached a conclusion. Correcting by including country-year fixed effects solves the problem, but it may require estimating too many parameters. From inspection of the $\Phi_{it}^{FDI}$ series, one might suggest the "cheaper" strategy of adding country-specific trends, most of the evolution in a country's overall barriers can be roughly approximated with a negative log-linear trend. In studies with long time periods, it may be necessary to inspect plots of $\Phi_{it}^{FDI}$ to check for breaks in the trends.

1.6 Decomposing the Growth of FDI

Two countries may invest more in each other for three reasons: The bilateral barriers to FDI may fall, the two countries may experience economic growth, raising the nominal value of the desired FDI stock abroad, or finally, the relative attractiveness of mutual investment may increase because the two countries' barriers to the rest of the world have gone up, lowering the competition for assets in the two countries.

FDI activity has indeed grown in recent years. With the time series for the inferred bilateral and overall barriers as well as total capital stocks at hand, it is possible to calculate the relative contributions of each of these three fac-
tors. Is the increase in FDI stocks mainly caused by lower costs of investing abroad, or is economic growth, in the form of domestic capital accumulation, driving the increase?

Rewrite the product of the FDI stocks between country $i$ and $j$ as follows:

$$ F_{ij} F_{ji} = \frac{F_{ij} F_{ji} F_{ij} F_{ji}}{K_i K_j} K_i K_j $$

The product of bilateral FDI stocks can then be expressed as

$$ F_{ij} F_{ji} = (\Phi_{ij}^{FDI})^2 \Phi_{ij}^{FDI} \Phi_{ji}^{FDI} K_i K_j , $$

that is, the two country's domestic capital stock times the two countries' overall barriers to FDI times the bilateral openness squared. To get the contributions of each of these factors over time, take logs and difference with the desired time period:

$$ \Delta \log(F_{ij} F_{ji}) = 2 \Delta \log(\Phi_{ij}^{FDI}) \Delta \log(\Phi_{ij}^{FDI} \Phi_{ji}^{FDI}) + \Delta \log(K_i K_j) \quad (1.5) $$

Table 4 presents these contributions of bilateral barriers ($\Phi_{ij}^{FDI}$), third-country effects ($\Phi_{ij}^{FDI} \Phi_{ji}^{FDI}$) and capital stocks ($K_i K_j$) in the growth of FDI stocks between 1985 and 2008.\(^9\) The growth rates are annualized and averaged across country pairs.

The first observation is the dominance of falling bilateral barriers as drivers of the growth of FDI, they typically explain three quarters of the FDI growth. Jacks, Novy and Meissner (2008) do a similar decomposition for trade flows. For the period 1950-2000, they find that falling trade costs (inferred in the same manner as FDI openness in this paper) explain only 33% of the growth in trade, the rest being attributable to economic growth. Novy (2008) report similar numbers for specific country pairs involving the US over the period 1970-2000, falling trade costs explain on average 40% of the growth in trade.

\(^9\) Following the discussion in footnote 7, an inflow into $i$ of greenfield FDI from a country $j$ will be attributed both to a decline in the bilateral barrier, to an increase in the capital stock in $i$ and to an increase in bidder competition (fall in $\Phi_{ij}^{FDI}$), with the latter two exactly offsetting each other. The Greenfield FDI inflow generated more capital, but this new capital is owned by country $j$, and other countries $h=j$ therefore own a lower share of the capital in $i$, mechanically generating more bidder competition for the total capital in $i$. 

1—23
Table 4: Decomposing the annual growth of FDI, 1985-2008

<table>
<thead>
<tr>
<th></th>
<th>Annual growth in FDI stocks</th>
<th>Contribution, change in FDI openness</th>
<th>Contribution, growth in capital stocks</th>
<th>Contribution, change in third-country barriers, bidder competition</th>
</tr>
</thead>
<tbody>
<tr>
<td>OECD average</td>
<td>41%</td>
<td>- 31% (75%)</td>
<td>+ 13% (32%)</td>
<td>+ -3% (-7%)</td>
</tr>
<tr>
<td>America</td>
<td>29%</td>
<td>- 19% (66%)</td>
<td>+ 12% (41%)</td>
<td>+ -2% (-7%)</td>
</tr>
<tr>
<td>Mexico</td>
<td>33%</td>
<td>- 23% (69%)</td>
<td>+ 12% (37%)</td>
<td>+ -2% (-6%)</td>
</tr>
<tr>
<td>Canada</td>
<td>26%</td>
<td>- 17% (66%)</td>
<td>+ 11% (43%)</td>
<td>+ -2% (-9%)</td>
</tr>
<tr>
<td>USA</td>
<td>28%</td>
<td>- 17% (62%)</td>
<td>+ 12% (43%)</td>
<td>+ -2% (-6%)</td>
</tr>
<tr>
<td>Oceania and South-East Asia</td>
<td>31%</td>
<td>- 21% (67%)</td>
<td>+ 12% (37%)</td>
<td>+ -2% (-5%)</td>
</tr>
<tr>
<td>Korea</td>
<td>47%</td>
<td>- 33% (70%)</td>
<td>+ 15% (33%)</td>
<td>+ -1% (-3%)</td>
</tr>
<tr>
<td>New Zealand</td>
<td>27%</td>
<td>- 19% (70%)</td>
<td>+ 10% (37%)</td>
<td>+ -2% (-7%)</td>
</tr>
<tr>
<td>Japan</td>
<td>27%</td>
<td>- 17% (65%)</td>
<td>+ 11% (40%)</td>
<td>+ -1% (-5%)</td>
</tr>
<tr>
<td>Australia</td>
<td>26%</td>
<td>- 16% (62%)</td>
<td>+ 11% (44%)</td>
<td>+ -2% (-6%)</td>
</tr>
<tr>
<td>Europe, rich</td>
<td>37%</td>
<td>- 30% (80%)</td>
<td>+ 11% (30%)</td>
<td>+ -4% (-10%)</td>
</tr>
<tr>
<td>Norway</td>
<td>44%</td>
<td>- 39% (87%)</td>
<td>+ 11% (26%)</td>
<td>+ -6% (-13%)</td>
</tr>
<tr>
<td>Sweden</td>
<td>39%</td>
<td>- 33% (85%)</td>
<td>+ 11% (27%)</td>
<td>+ -5% (-12%)</td>
</tr>
<tr>
<td>Austria</td>
<td>46%</td>
<td>- 37% (81%)</td>
<td>+ 12% (26%)</td>
<td>+ -3% (-7%)</td>
</tr>
<tr>
<td>Switzerland</td>
<td>29%</td>
<td>- 23% (81%)</td>
<td>+ 11% (37%)</td>
<td>+ -5% (-18%)</td>
</tr>
<tr>
<td>Netherlands</td>
<td>37%</td>
<td>- 29% (79%)</td>
<td>+ 13% (34%)</td>
<td>+ -5% (-13%)</td>
</tr>
<tr>
<td>Germany</td>
<td>33%</td>
<td>- 26% (78%)</td>
<td>+ 10% (30%)</td>
<td>+ -3% (-8%)</td>
</tr>
<tr>
<td>Denmark</td>
<td>36%</td>
<td>- 28% (77%)</td>
<td>+ 11% (32%)</td>
<td>+ -3% (-9%)</td>
</tr>
<tr>
<td>France</td>
<td>42%</td>
<td>- 32% (77%)</td>
<td>+ 12% (29%)</td>
<td>+ -2% (-6%)</td>
</tr>
<tr>
<td>Italy</td>
<td>39%</td>
<td>- 30% (76%)</td>
<td>+ 11% (28%)</td>
<td>+ -2% (-5%)</td>
</tr>
<tr>
<td>UK</td>
<td>29%</td>
<td>- 21% (72%)</td>
<td>+ 11% (39%)</td>
<td>+ -3% (-11%)</td>
</tr>
<tr>
<td>Europe, catch-up</td>
<td>45%</td>
<td>- 33% (75%)</td>
<td>+ 14% (31%)</td>
<td>+ -3% (-6%)</td>
</tr>
<tr>
<td>Iceland</td>
<td>52%</td>
<td>- 42% (81%)</td>
<td>+ 15% (29%)</td>
<td>+ -5% (-10%)</td>
</tr>
<tr>
<td>Spain</td>
<td>53%</td>
<td>- 41% (77%)</td>
<td>+ 14% (27%)</td>
<td>+ -2% (-4%)</td>
</tr>
<tr>
<td>Portugal</td>
<td>39%</td>
<td>- 29% (74%)</td>
<td>+ 14% (34%)</td>
<td>+ -3% (-8%)</td>
</tr>
<tr>
<td>Finland</td>
<td>35%</td>
<td>- 25% (72%)</td>
<td>+ 12% (34%)</td>
<td>+ -2% (-6%)</td>
</tr>
<tr>
<td>Ireland</td>
<td>44%</td>
<td>- 30% (67%)</td>
<td>+ 15% (33%)</td>
<td>+ -0% (-1%)</td>
</tr>
<tr>
<td>Central and Eastern Europe</td>
<td>55%</td>
<td>- 43% (79%)</td>
<td>+ 14% (26%)</td>
<td>+ -3% (-5%)</td>
</tr>
<tr>
<td>Poland</td>
<td>67%</td>
<td>- 55% (81%)</td>
<td>+ 15% (23%)</td>
<td>+ -3% (-4%)</td>
</tr>
<tr>
<td>Czech Rep.</td>
<td>49%</td>
<td>- 40% (81%)</td>
<td>+ 13% (26%)</td>
<td>+ -4% (-8%)</td>
</tr>
<tr>
<td>Slovakia</td>
<td>65%</td>
<td>- 52% (80%)</td>
<td>+ 16% (24%)</td>
<td>+ -3% (-4%)</td>
</tr>
<tr>
<td>Hungary</td>
<td>49%</td>
<td>- 39% (78%)</td>
<td>+ 14% (28%)</td>
<td>+ -3% (-6%)</td>
</tr>
<tr>
<td>Turkey</td>
<td>48%</td>
<td>- 36% (76%)</td>
<td>+ 14% (29%)</td>
<td>+ -2% (-4%)</td>
</tr>
<tr>
<td>Greece</td>
<td>49%</td>
<td>- 37% (75%)</td>
<td>+ 15% (30%)</td>
<td>+ -3% (-6%)</td>
</tr>
</tbody>
</table>

Decomposition, according to equation (1.5), of the growth in the product of bilateral FDI stocks, averaged for each country (unweighted) across country pairs. Shares of total contribution in parentheses. In each group, countries are ordered according to the share of FDI growth explained by declining barriers.

In fact, the numbers in table 4 are more in line with what happened to international trade in the period 1870-1913, the so-called first wave of global-
ization. In this period world trade boomed, and Jacks, Novy and Meissner show that 56% of that expansion could be attributed to falling trade costs. A policy lesson can be drawn from this analogy: As the collapse in global trade following the First World War and the Great Depression has shown, an expansion in trade or FDI, which is driven by reduced bilateral costs is more fragile. Barriers can be re-erected. Although trade costs in the late 19th century fell both for technological and political reasons, the protectionist era of 1921-39 brought trade costs back to their pre-Victorian level (see Jacks, Novy and Meissner (2008)).

Table 4 also reveals that for some countries, falling FDI barriers have played a smaller role. As the regional averages reveal, these countries are non-European, with Ireland as the only exception. Countries that have a contribution share from $\phi_{ijt}^{FDI}$ below 70% also have lower than average growth in FDI, again Ireland is the exception. The correlation between the growth in FDI stocks and the share explained by $\phi_{ijt}^{FDI}$ is 0.58.

All bilateral investment stocks are suppressed by the decline in third-country barriers, FDI stocks have grown by 1% to 5% less per year because of crowding out. The negative contribution tends to be larger for small open economies.

### 1.7 Further Uses of Inferred FDI Barriers

Inferred FDI barriers have uses beyond the direct explorations that are the focus of this paper. In related fields, it can be used as an explanatory or control variable. How do FDI barriers predict trade in goods, migration, or similar cross-border phenomena? Of particular interest here is perhaps the residual from the regressions in section 1.4. Do unexplained barriers to FDI correlate with trade flows or migration stocks?

Models like Ramondo and Rodriguez-Clare (2010) need barriers to FDI as inputs, and inferred barriers to FDI are an easy and straightforward way to calibrate these models, see Eaton, Kortum, Neuman and Romalis (2010) for a similar application of inferred trade costs.

Finally, the methodology of inferring barriers, applied here to FDI, can be applied elsewhere. The gravity equation describes very well how many economic and social activities propagate across space, examples include migration, traffic, tourism, and social interactions. In principle, we can use the inference procedure to study the barriers to all these phenomena, the only con-
ditions being that we can measure a location's "interaction with itself" meaningfully, and that the locations' interactions are not too unbalanced (an issue for tourism, for example).

We may of course wish for theoretical foundations for why the gravity equation describes a given phenomena before applying the inference procedure, and the above analysis also shows the usefulness of a theoretical framework. On the other hand, social science theory is not formed in isolation from empirical insights, and any theory of, say, social interactions across space that predicts a pattern at odds with an empirical regularity as the gravity equation would be hard to believe.

1.8 Conclusion

Many barriers to FDI are inherently difficult to observe, but this paper circumvents the problem by inferring the barriers from FDI data. The resulting measure is easy to compute and analyze, and the results presented in this paper are difficult to obtain in any other way. The methodology relies on the gravity equation, one of the strongest and most well-documented empirical relationships in economics, and works whatever theory one believes rationalizes that relationship.

The approach uncovers how barriers to FDI have been declining among virtually all of the 324 OECD country pairs examined. This universal decline suggests either technological explanations, multilateral policy liberalizations, or a combination of the two. The decline in FDI barriers has been faster for "catch-up" countries (Finland, Iceland, Ireland, Portugal, Korea and Spain) and "emerging" countries (Czech Rep., Slovak Rep., Hungary, Poland, Greece, Turkey and Mexico).

Regressing the inferred barriers to FDI on variables which the previous literature has found to impede or encourage FDI enables an assessment of the importance of each. The regressions confirm the importance of geography and language; FDI barriers are dramatically lower if two countries used to be one, or if one colonized the other in the past. The hypothesis from the proximity-concentration literature that large markets attract more FDI also receives support. The main determinants of FDI barriers are country-specific, however. Countries with very low corporate taxes are especially successful at attracting FDI, while countries with low GDP per capita tend to have high barriers. The crucial role played by GDP per capita (it is also an important determinant of bilateral barriers) warrants further investigation.
Decomposition reveals that the main driver of the growth in FDI from 1985 to 2008 has been falling barriers, economic growth in the form of capital accumulation is less than half as important. Moreover, the decomposition reveals a crowding-out effect on FDI: Had there been an infinite stock of firms to acquire in each country, bilateral FDI stocks would have grown by 3% more each year. If this crowding-out is not controlled for, estimates of e.g. the FDI-impeding effect of distance will be biased upwards.

In sum, applying the technique of inferred barriers, which is widely used in international trade, to FDI has provided substantial insights into the size, distribution and evolution of the barriers to FDI, as well as the constituents of these barriers. I confirm and nuance results from existing studies of FDI barriers and provide novel results, which are hard to obtain using other methods.

**Appendix 1: Log-log regressions**

<table>
<thead>
<tr>
<th>Specification</th>
<th>1, (i,-)FE</th>
<th>2, (i,j)-FE</th>
<th>3, (i,j)-FE</th>
<th>4, (i,j)-FE</th>
<th>5, (i,j)-j)-FE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance_{ij}</td>
<td>-0.72 (0.03)</td>
<td>-22.7</td>
<td>-0.71 (0.03)</td>
<td>-21.2</td>
<td>-0.73 (0.03)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neighbors_{ij} (0,1)</td>
<td>0.28 (0.10)</td>
<td>22%</td>
<td>0.64 (0.07)</td>
<td>49%</td>
<td>0.37 (0.07)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Common language_{ij} (0,1)</td>
<td>2.43 (0.11)</td>
<td>1031%</td>
<td>0.31 (0.08)</td>
<td>36%</td>
<td>1.62 (0.06)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colonial past_{ij} (0,1)</td>
<td>-0.11 (0.14)</td>
<td>-8%</td>
<td>1.43 (0.10)</td>
<td>319%</td>
<td>0.22 (0.09)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GDP_{it}×GDP_{jt}</td>
<td>0.50 (0.02)</td>
<td>29.4</td>
<td>1.11 (0.17)</td>
<td>6.5</td>
<td></td>
</tr>
<tr>
<td>(Per capita GDP_{it})×(Per capita GDP_{jt})</td>
<td>2.89 (0.06)</td>
<td>51.5</td>
<td>1.68 (0.17)</td>
<td>9.9</td>
<td>1.62 (0.39)</td>
</tr>
<tr>
<td>(Population in 1985)×(Population in 1985)</td>
<td>0.46 (0.03)</td>
<td>32.2</td>
<td>0.61 (0.03)</td>
<td>12.4</td>
<td>2.33 (0.62)</td>
</tr>
<tr>
<td>Year dummies (γ)</td>
<td>Yes [sum 57.5]</td>
<td></td>
<td>Yes [sum 62.5]</td>
<td></td>
<td>Yes [sum 31.0]</td>
</tr>
<tr>
<td>Country fixed effects (c_{i} and c_{j}).</td>
<td>No</td>
<td></td>
<td>Yes [sum 321.3]</td>
<td></td>
<td>No</td>
</tr>
</tbody>
</table>

4269 observations. %-effect: Percentage change in \( \phi_{ij}^{FDI} \) when independent variable goes from 0 to 1, calculated as exp(-\( b \)) – 1.

Estimation method: Ordinary least squares (with and without fixed effects), estimated coefficients are elasticities. Robust standard errors in parentheses. Square parentheses contain t-statistics, corresponding to the explanatory variables' importance in explaining the variation in the dependent variable. * ** ***: significant at 1%, 5% and 10%-level, respectively.
Table A1 reports the results of running the regressions from table 2 in log-log rather than Poisson quasi maximum likelihood, along with one additional regression in column 5, where the error term is specified as
\[
\exp(\gamma_t)\eta_{ijt} = \exp(c_{it})\exp(c_{jt})\zeta_{ijt}.
\]

The only marked change in coefficients when using country-year fixed effects is for population, here there is a markedly higher coefficient, but low explanatory power. The other coefficients have roughly the same (biased) values.

References
2 Intransparent Markets and Intra-Industry Trade

Christian Gormsen

Abstract:
Buyers are typically unaware of the full set of offers when making a purchase. This paper examines how international trade interacts with this problem of market intransparency. Sellers must communicate their offers through costly advertising, but cannot reach all buyers. Consequently, no market clearing price exists, and sellers randomize over an equilibrium price distribution. Letting sellers advertise their offers abroad leads to international trade, which would not take place under complete information. Buyers then receive more offers, leading to lower prices and welfare gains. Sellers in the model are identical, but appear heterogeneous due to their price randomization. In larger and more open economies, prices and markups will be lower, and exports are primarily realized by sellers who charge low prices. These predictions are similar to those of trade models where firm heterogeneity is assumed exogenously.

Keywords: advertising, intra-industry trade, firm heterogeneity, price dispersion

JEL-codes: F12, D83, D43, M37
2.1 Introduction

Information costs have long been thought to matter for international trade flows. Stylized facts of modern trade, such as the consistent findings of significantly higher trade flows between countries with a common language and the trade-promoting effect of ethnic networks, strongly support the hypothesis. To date, however, theoretical treatments have been sparse. Against this background, Anderson and Van Wincoop (2004, p720) conclude their review of the literature on information costs by stating that "More careful modeling of the underlying information costs in future work will probably be illuminating."

This paper takes up the task. The point of departure is the literature on how buyers and sellers match, a literature that accounts for the fact that many real world markets are "intransparent": The information necessary to carry out an exchange, such as who sells, what price these sellers charge and what the quality offered is, will not automatically reach buyers. Rather, sellers spend considerable resources on advertising their goods. Modeling intransparent markets and the associated advertising costs in an open economy setting uncovers intricate interactions between international trade and information costs. In particular, new leaves appear on two of the main current research branches in international trade: intra-industry trade and the role of firm heterogeneity in an open economy.

In the model, the motive for intra-industry trade is generated by advertising costs – if information could diffuse costlessly, entering a foreign market would not be profitable. Moreover, the analysis offers a new perspective on the role of firm heterogeneity, which has been a key issue in international trade since the influential paper by Melitz (2003). When markets are intransparent, different pricing strategies are equally profitable. Even though sellers are identical, some will sell many units at low prices, others will charge high prices and sell fewer units. The pattern is similar to the one generated in Melitz (2003) by differences in productivities across firms, as are the effects of international trade on sector composition. The novel hypothesis offered by this paper is that some of the heterogeneity and variations in international activity observed in the firm-level data may arise from similar firms following different strategies.

I construct a model with two types of agents, buyers, who demand one unit of a good, and sellers, who produce it. Buyers are initially unaware of the
characteristics of offers, and sellers must therefore advertise their offers. For expositional clarity, the focus is on homogeneous goods, where advertisement reduces to price posting. In this interpretation, the model is intended to describe industries where goods are relatively cheap, and where most buyers are primarily sensitive to price.\(^{10}\) Relatively cheap goods imply that any gains for buyers of actively searching for offers, rather than passively evaluating offers received, are likely to be outweighed by time costs.

The setup for the closed economy is adapted from the wage posting model of Mortensen (1990, 2003). Sellers' advertising technology is similar to the seminal advertisement model of Butters (1977). Advertisement is non-rival in its form, one can think of sellers posting offers in mass media or in the public space. Even if sellers to some degree can segment buyers, this form of advertising inherently has some randomness to it. As a consequence, if there are many buyers, it becomes too expensive for the individual seller to reach them all. The randomness in advertising also leads to an ex post heterogeneity among buyers: Some buyers receive offers from multiple sellers and can select the best one, others receive no offer at all.

In this setting, there is no equilibrium price on the market: sellers will either want to price lower than other sellers, or to price higher, hoping that the buyer gets no better offer. The equilibrium outcome is a price distribution with no mass points, over which sellers randomize their price. Each seller thus charges a different price, although the good is homogeneous. The price dispersion is sustained by unfortunate buyers, who, upon receiving only one expensive offer, have no better option for purchase.

When sellers are able to contact buyers abroad, there will be two-way international trade in the model. The export market presents an entirely new set of buyers to sellers, and initially there is no risk of reaching the same buyer twice with the advertising campaign. The net implication of international trade is an increase in the average number of offers that a buyer learns about and a downward shift in the price distribution. International trade pushes the model towards the Bertrand equilibrium, to the benefit of buyers. Were it not for the

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\(^{10}\) A few examples could be kitchen utensils, detergents, basic office equipment, and also copyrighted goods with multiple sellers, such as a particular book or recorded piece of music. As outlined in section 4, the modeling approach generalizes to quality-adjusted prices of non-homogeneous goods, where advertisement must transmit more information than the price. With this reinterpretation, the model covers any industry where goods are not tailored to fit individual buyers' particular tastes or needs.
information frictions, there would be no reason for international trade to occur, as both countries would be in Bertrand equilibrium already.

Associated with the information costs is therefore a new gain from international trade, a transparency gain: Buyers gain from receiving more information and from the subsequent intensified price competition. The closest parallel in the trade literature is the gain from trade put forward by the Cournot models of Brander (1981) and Brander and Krugman (1983), where welfare gains arise from the strategic responses of firms when the economy is opened.

International advertisement is likely to be easier between countries that share languages. Lower costs of export advertising will enable sellers to export more, the model thus presents an explicit channel for the well-established result that countries with shared languages trade more, see Melitz (2008) for a detailed empirical treatment.

Price dispersion, even for homogeneous goods or within specific brands, is a consistent finding in economics. It has been documented empirically by, among others, Stigler (1961) and Pratt, Wire and Zeckhauser (1979); Clay et al. (2001) and Feenstra and Shapiro (2003) document that the phenomenon has not disappeared in the internet age. A rich theoretical literature has put forward different explanations for how price dispersion may occur, Butters (1977) and Burdett and Judd (1983) are seminal papers, see Baye, Morgan and Scholten (2006) for a recent review.

The result that information costs may encourage international trade differs markedly from Arkolakis (2008), which to my knowledge is the only other paper modeling information costs of international trade explicitly. Arkolakis (2008) shares a building block with this paper, advertisement costs in line with Butters (1977). The crucial difference is specification of demand; Arkolakis (2008) builds on a love-of-variety model. To draw lines sharply: Suppose a buyer receives advertisement about five different tumble-driers. In Arkolakis (2008), the buyer would purchase all five, in this paper the buyer selects the best of the five offers.

The next section sets up the model for the closed economy, the economy is opened in section 2.3. Section 2.4 features a discussion of the model's predictions and how they may be tested, along with extensions to quality differences and additional forms of trade costs. Concluding remarks follow in the final section 2.5.
2.2 The Closed Economy

There are \(n\) buyers, \(m\) sellers and one homogenous good. Buyers can either be thought of as consumers, or as firms wishing to buy an intermediate input. They each demand one unit of the good and have common reservation price of \(\bar{p}\). This demand arises from a utility function of the form

\[
U(p) = \begin{cases} 
\bar{p} - p & \text{if } p < \bar{p} \\
0 & \text{otherwise}
\end{cases}
\]  \tag{2.1}

Sellers produce the good at marginal cost \(c\), with \(c < \bar{p}\). Initially, buyers neither know individual sellers nor the prices they are charging for the good, and they are therefore unable to make a purchase. Sellers must inform buyers of their offers through advertising. The good is homogenous, and so the only information buyers need is the price; advertising therefore reduces to price posting. Throughout the analysis \(m\) and \(n\) are assumed to be large, there are many buyers and sellers.

The costs of price posting fall into two parts. There is a fixed cost, \(f_v\), of employing the relevant people and have them design the advertising campaign. Thereafter, the cost of reaching \(k\) distinct buyers with the campaign and thereby inform them of the price of the product is described by the function \(v(k/n)\). Price posting hits buyers at random, so the seller is unable to take into account if a buyer has already received offers from other sellers. Moreover, the campaign may hit the same buyer multiple times, and this leads to convexity of \(v(k/n)\): The larger the fraction of the population reached by the campaign, the higher the probability that resources will be wasted on reaching the same buyer twice, \(v'(k/n) > 0\) and \(v''(k/n) > 0\). In the end, reaching all other buyers becomes unprofitable:

\[
\lim_{k \to n} \frac{v'(k/n)}{n} > (\bar{p} - c),
\]

the cost of reaching the last buyer is higher than what the seller could potentially earn.\(^\text{11}\)

\(^{11}\) The price posting technology does not have to be completely random. The modeling is consistent with sellers splitting buyers into segments and advertising to some segments only. Buyers are homogenous, however: Sellers’ choices of which segments to target are uncorrelated.
The timing of the game is as follows: In the first stage, each seller chooses the scope of her price posting campaign, \( k \), and her price \( p \). In the second stage, each buyer picks the best among the offers he learns about. If a buyer only receives one offer, he buys the good if its price is lower than the maximum willingness to pay; if there is more than one offer, the buyer will accept the cheapest offer. In case there are several offers with the lowest price, the buyer selects randomly among these. Buyers can only buy offers they learn about, and actively searching for goods is assumed to be too costly.\(^{12}\)

### 2.2.1 Price Randomization

The expected profit earned by seller \( j, j = 1, 2, \ldots, m \), is:

\[
\pi_j(p_j, k_j) = Q(p_j)(p_j - c)k_j - v(k_j/n) - f_v, \quad (2.2)
\]

where \( Q(p) \) denotes the probability that a buyer purchases the good when the seller charges price \( p \).

Prior to finding the sellers' optimal strategies for pricing and contacting buyers, it is helpful to consider what the equilibrium must look like. Let \( F(p) \) denote the cumulative distribution of prices offered by sellers. In equilibrium, the following characteristic will hold:

**Proposition 1:** Price dispersion (Adapted from Mortensen, 2003):

Any equilibrium distribution of price offers, represented by the c.d.f. \( F(p) \) is continuous and has connected support with upper support \( \bar{p} \) and lower support no less than \( c \).

A proof is given in Appendix A. Continuity of \( F(p) \) implies that there is no equilibrium where sellers set the same price. The intuition for this is quite straightforward: If a buyer receives several offers with the same price, a seller will always want to reduce her price slightly and be sure that the buyer accepts her offer rather than selects an offer at random. This undercutting does not continue, though: If all sellers were to price at \( c \), a seller can earn positive profits by setting \( p = \bar{p} \): the probability that the buyer gets no other offer is positive, since no seller contacts all buyers.

\(^{12}\) A sufficient condition to rule out buyer search is that the expected cost of finding an offer through search is higher than \( \bar{p} - c \). This condition is more likely to hold for relatively cheap goods. See also the discussion in footnote 14.
That the upper bound of the distribution must be $\bar{p}$ is also quite apparent: If a seller is charging the highest price, she can only make a sale if the buyer gets no other offer. Given that the buyer gets no other offer, she might as well charge him $\bar{p}$.

Maximization of (2.2) with respect to $p_j$ and $k_j$ leads to the first order conditions:

$$Q'(p_j)(p_j - c) = Q(p_j) \quad (2.3)$$

and $Q'(p_j)(p_j - c) = v'(k_j/n)/n.$ \(2.4\)

In Appendix A, it is shown that all sellers will contact the same number of buyers, $k_j = k$, independently of the prices they are charging. This symmetry in price posting simplifies the derivation of the mixed strategy equilibrium in prices. All prices offered must give the same expected profits, $\pi(p, k) = \pi(p', k)$, or

$$Q(p)(p - c) = Q(\bar{p})(\bar{p} - c) \quad (2.5)$$

To derive $Q(p)$, consider the number of offers a buyer receives, call it $X$. Buyers are targeted at random, and so $X$ must be binomially distributed: The probability of being hit by a given seller $j$ is $k/n$ (for all $j$), and there are $m$ sellers making contacts, which gives us the two parameters of the binomial distribution. The expected number of offers a buyer receives will be their product, $X = mk/n$. When $m$ and $n$ are large (and $k/n$ therefore small), the distribution of $X$ can be well approximated by the Poisson distribution:

$$\Pr(X = x) = \frac{e^{-\lambda} \lambda^x}{x!}, \text{ where } \lambda = \frac{mk}{n}. \quad (2.6)$$

The poison parameter $\lambda$ will be key to the model's results. It is equal to the expected number of offers a buyer receives, and as will be shown shortly changes in $\lambda$ will shift the distribution of prices. I will refer to $\lambda$ as the contact frequency.

As hinted in the reasoning behind proposition 1, there are two forces governing sellers' choice of price: The incentive to raise the price and earn a high mark-up, hoping that the buyer does not get a better offer, and the incentive to lower the price, increasing the probability of undercutting the other offers that a buyer receives. The equilibrium distribution of prices offered, $F(p)$, is the distribution where these two incentives balance each other out. For a given
price offer distribution, the probability that price $p$ is the lowest among $x$ other offers is $[1-F(p)]^x$. Using this, the purchase probability $Q(p)$ can be computed as

$$Q(p) = \sum_{x=0}^{\infty} [1-F(p)]^x \frac{e^{-\lambda} \lambda^x}{x!}$$

Inserting (2.7) in (2.5) and using that $F(\bar{p}) = 1$ gives the distribution of prices that is consistent with sellers earning the same profits:

$$e^{-\lambda \bar{p}}(p - c) = e^{-\lambda}(\bar{p} - c)$$

$$\Leftrightarrow F(p) = 1 - \frac{1}{\lambda} \ln \left( \frac{\bar{p} - c}{p - c} \right)$$

(2.8)

$F(p)$ has lower support $e^{-\lambda} \bar{p} + (1 - e^{-\lambda})c$ and upper support $\bar{p}$. In equilibrium, sellers randomize their price over $[e^{-\lambda} \bar{p} + (1 - e^{-\lambda})c, \bar{p}]$ in such a manner that prices offered will follow the distribution $F(p)$. If the contact frequency $\lambda$ tends to infinity, such that each buyer observes all prices offered, prices will approach the Bertrand equilibrium: The lower support tends to $c$, and $F(p) = 1$ for all $\bar{p} > c$, all sellers would price at marginal cost.$^{13}$

The price distribution is plotted in Figure 1 for two different values of $\lambda$.

---

$^{13}$ Even though there is price dispersion in the economy, there is no room for arbitrage: A third party, buying the good at a price $p' > c$ with the purpose of resale would face the same information problem as the sellers and would have to perform price posting on his own. This third party would effectively correspond to a seller producing at higher marginal cost, which is unprofitable relative to entering as a seller.
The more offers buyers learn about on average (higher $\lambda$), the more the incentive for sellers to undercut other offers will dominate, and prices will be lower stochastically. As long as there is a positive probability that some buyers only know one offer ex post, price dispersion can exist in equilibrium, even though the good is homogeneous. Buyers accepting unfavorable offers do not irrationally perceive these as superior, they simply do not know of any better offers.\textsuperscript{14}

The price dispersion generates "pseudo-heterogeneity" among sellers. In one extreme, a seller sets a price of $p$ and sells an expected quantity of $e^{-\lambda}k$, the other extreme is a seller setting a price of $e^{-\lambda}p + (1 - e^{-\lambda})c$ selling expected quantity of $k$. Observationally, this pattern is equivalent to the one generated in Melitz (2003) by differences in productivities.

With the price distribution determined, the optimal number of contacts follows from the first order condition (2.4). As any price offered gives the same expected mark-up, this condition reduces to

\textsuperscript{14} Butters (1977) provides a discussion of allowing for buyer search in a related framework. If search is not too costly, buyers will search if the offers they receive are all priced above a certain threshold $p'$. This will lead sellers never to price above $p'$, the equilibrium now holding with $p'$ replacing the reservation price.
\[ e^{-\lambda}(\bar{p} - c) = \frac{v'(k/n)}{n} \] (2.9)

2.2.2 The Free Entry Condition

New sellers will enter until each seller has expected profit of zero. Entry increases the contact frequency \( \lambda \), lowering the expected markup and forcing each seller to reduce her price posting campaign. The process continues until the average cost of price posting equals expected markup. Setting expected profits (2.2) to zero gives exactly this condition:

\[ e^{-\lambda}(\bar{p} - c)k = v(k/n) + f_v. \] (2.10)

Combining this zero profit condition with the optimality condition for \( k \), (2.9), one gets

**Lemma 1:** Buyers contacted under free entry

\[ \frac{k}{n} = \frac{v(k/n) + f_v}{v'(k/n)} \] (2.11)

Under free entry, \((k/n)\) must be at the level where the average cost of price posting is minimized, this happens where the marginal price posting cost equals the average price posting cost. The fraction of buyers reached by the individual seller is therefore determined uniquely by price posting technology.

With the price posting scope determined in Lemma 1, the contact frequency \( \lambda \) that prevails under free entry may be found from (2.9) as

\[ \lambda = \ln \left( \frac{n(\bar{p} - c)}{v'(k/n)} \right) \] (2.12)

and since \( \lambda = mk/n \), the number of sellers under free entry is

\[ m = \frac{n}{k} \ln \left( \frac{n(\bar{p} - c)}{v'(k/n)} \right). \] (2.13)
In markets with more buyers, the contact frequency will be higher. As a seller has a lower risk of hitting the same buyer twice with the price posting campaign, she is able to reach more buyers at the same cost when the market is larger. With a higher contact frequency, lower prices and mark-ups follow (stochastically), and larger markets will also attract more sellers. These pro-competitive effects of a larger market size resemble those of Melitz and Ottaviano (2008).

The contact frequency will be higher the less price posting the individual seller does. The reason is the convexity of \( v(k/n) \): One seller spending a given amount of advertising will reach fewer buyers than two sellers spending the same amount. From (2.11), \( k/n \) will be lower with a lower fixed cost of price posting.

The benefit to buyers from a lower contact frequency is twofold: Each buyer has on average more offers to select among, and the proposed prices are stochastically lower. Sellers earn margins on each sale but spend it all on advertising and therefore earn no expected profits. Welfare in the economy therefore reduces to the utility (or "buyer surplus") accruing to buyers that pay less than their reservation price \( \bar{p} \), as described in (2.1). Buyers receiving no offers are equivalent to buyers paying \( \bar{p} \). By the law of large numbers, total welfare, \( W \), is equal to the sum of each buyer's expected utility:

\[
W = n[\bar{p} - E_b(p)]
\]

where \( E_b(p) \) is the price each buyer can expect to pay ex ante, before any price posting takes place.

In Appendix A, it is shown that \( E_b(p) = c + e^{-\lambda}(\bar{p} - c)(\lambda + 1) \).

**Proposition 2:** Welfare and the intransparency loss

\[
W = n(\bar{p} - c)(1 - e^{-\lambda}(\lambda + 1)).
\]  

(2.14)

Welfare is the Bertrand welfare level, \( n(\bar{p} - c) \), scaled down by an "intransparency loss", \( e^{\lambda}(\lambda + 1) \in (0,1) \), which represents how much revenue sellers can earn on buyers' lack of information. An increase in the contact frequency will reduce the intransparency loss and push welfare towards the Bertrand benchmark.


2.3 Opening the Economy

The main insights of the model are more clearly exposed in a two-country world, but the model can be generalized to any number of countries. Consider two countries Home (H) and Foreign (F), each country having an industry with sellers and buyers of the type described in section 2.2. A country has \( n_l \) buyers, \( l = H, F \), all with common reservation price \( \bar{p} \).

In addition to communicating their offers to domestic buyers, the \( n_l \) sellers may now choose to contact buyers abroad as well. The cost of posting prices abroad for a seller located in country \( l \) is described by the function \( v_x(k_x^l / n^h) \), where \( k_x^l \) is the number of foreign buyers in country \( h \) reached by the campaign. (Superscript \( h \) indicates "the other country", \( h = L, F \) and \( h \neq l \). Subscript \( x \) signifies the foreign market from the seller's perspective, "export variables"). Similarly to domestic price posting costs, \( v_x'(k_x^l / n^h) > 0 \), \( v_x''(k_x^l / n^h) > 0 \) and

\[
\lim_{k_x^l \to n^l} \frac{v_x'(k_x^l / n^h)}{n^h} > (\bar{p} - c).
\]

Cultural and language barriers, along with geographic distance make price posting abroad relatively more expensive: for any \( k/n \), \( v_x'(k/n) > \nu(k/n) \).

Because a given campaign scope costs more on the export market, but faces a similar risk of reaching the same buyer several times, export price posting costs rise faster than their domestic counterpart: \( v_x'(k/n) > \nu'(k/n) \) for any \( k/n \). However, a seller can use some common resources for the foreign and domestic price posting campaigns. There may be a fixed cost of translating, modifying and launching the price posting campaign abroad, but it is lower than \( f_v \), i.e. \( v_x(1/n^h) < f_v \).\(^{15}\)

A seller in country \( l \) has expected profit of:

\[
\pi(p, k^l, p_x, k_x^l) = Q^l(p)(p - c)k^l + Q^h(p_x)(p_x - c)k_x^l - v(k^l / n^l) - v_x(k_x^l / n^h) - f_v
\]

(2.15)

The pricing behavior of sellers carries over from the closed economy:

\(^{15}\) Introducing additional per-unit trade costs into the model is possible, but cumbersome. For clarity, they are left out. A discussion is provided in section 4.
Proposition 3: Pricing in the open economy

All sellers making offers in country $l$, both domestic and exporters from country $h$, will randomize over the same price offer distribution, $F^l(p)$, given by

$$F^l(p) = 1 - \frac{1}{\lambda^l} \ln \left( \frac{\bar{p} - c}{p - c} \right).$$

(2.16)

with support $\left[ \exp(-\lambda^l)\bar{p} + (1 - \exp(\lambda^l))c, \bar{p} \right]$.

The proof goes as follows: The purchase probability for a given price is the same whether the good is offered by an exporter or a domestic seller, and the upper bound on the equilibrium price offer distribution is equal to $\bar{p}$ for both domestic sellers and exporters. The condition that any price on the support of the equilibrium price offer distribution must give the same profit as offering $\bar{p}$, reduces to

$$\exp(-\lambda^l F^l(p_x)(p_x - c))k^h_x = \exp(-\lambda^l)(\bar{p} - c)k^h_x$$

(2.17)

for exporters from $h$, and to

$$\exp(-\lambda^l F^l(p)(p - c))k^l = \exp(-\lambda^l)(\bar{p} - c)k^l$$

for domestic sellers in $l$. These two conditions both lead to (2.16).

The domestic and export price posting scopes are set to maximize (2.15). A seller in $l$ thus sets her domestic price posting scope $k^l$ to satisfy

$$\frac{v^l(k^l / n^l)}{n^l} = \exp(-\lambda^l)(\bar{p} - c),$$

(2.18)

whereas the export price posting scope $k^l_x$ satisfies

$$\frac{v^l(k^l_x / n^h)}{n^h} = \exp(-\lambda^h)(\bar{p} - c)$$

(2.19)

the expected markups have been inserted in both expressions. It follows that the values for $k^l$ and $k^l_x$ do not vary across sellers in $l$. Equations (2.18) and (2.19) hold for each country, using this, one gets
which implies that $k^l > k^h_x$: A domestic seller reaches more consumers with her price posting campaign than a foreign seller.

With price posting scopes being equal across sellers, the contact frequency $\lambda^l$ for the open economy can be expressed as:

$$\lambda^l = \frac{k^l m^l + k^h_x m^h}{n^l}.$$  \hspace{2cm} (2.21)

Comparing with the closed economy contact frequency of $\lambda = km/n$, it is not yet clear whether opening the economy will increase $\lambda$. It may be that the import competition causes domestic sellers to contract their price posting expenditures or exit to such a degree that the net effect on $\lambda$ is a decrease.

### 2.3.1 The Free Entry Equilibrium

As for the closed economy, free entry implies that sellers must have expected profits equal to zero:

$$\exp(-\lambda^l)(\bar{p}-c)k^l + \exp(-\lambda^h)(\bar{p}-c)k^h_x = v(k^l / n^l) + v_x(k^l_x / n^h) + f_v$$  \hspace{2cm} (2.22)

The zero profit condition, combined with the optimality conditions for price posting scopes, (2.18) and (2.19), gives a relation between a seller’s domestic and export price posting scopes:

$$(k^l / n^l) = \frac{v(k^l / n^l) + v_x(k^l_x / n^h) - v_x(k^l_x / n^h)k^l_x / n^h)}{v(k^l / n^l)}.$$  \hspace{2cm} (2.23)

By the convexity of $v_x(k^l_x / n^h)$, the term $v_x(k^l_x / n^h) - v_x(k^l_x / n^h)k^l_x / n^h)$ is negative, so, comparing to (2.11), $k^l / n^l$ decreases when the economy is opened. Sellers reallocate resources from domestic to export price posting and reach fewer buyers on the domestic market. Lemma 2 summarizes the properties of the domestic and export price posting scopes.
Lemma 2: Open economy price posting scopes
The equilibrium price posting scopes under free entry are uniquely determined by (2.20) and (2.23) holding in both countries, as these four equations define four monotonous one-for-one relationships in the four variables \((k^H, k^h, k^F, k^f)\). From (2.20), the fraction of domestic buyers reached by each individual seller is lower in the open economy. From (2.20), \(k^l > k^h\), a domestic seller still reaches more buyers in market \(l\) than do sellers exporting from \(h\).

With \(k^l\) determined, again by price posting technology only, but in a more complicated manner, the equilibrium contact frequency under free entry can be found from (2.18):

Proposition 4: Trade and the contact frequency
In the open economy, the contact frequency that prevails under free entry is given by

\[
\lambda^l = \ln\left(\frac{n^l(\bar{p} - c)}{v^l(k^l / n^l)}\right).
\]

(2.24)

Since \(k^l\) is lower in the open economy and \(v\) is convex, the contact frequency is higher in the open economy. The increased contact frequency implies that price offers are stochastically lower in the open economy – (2.8) stochastically dominates (2.16) – and that the lower price bound is closer to \(c\).

Because the export market presents a whole new set of buyers to the seller, with initially no risk of hitting the same buyer twice, export price posting is on the margin both more efficient and more profitable. When sellers in both countries reduce their domestic price posting to finance export price posting, the net effect (in both countries) is therefore an increase in \(\lambda^l\). As buyers on average receive more offers, sellers reduce prices. Although the mechanism is different, this outcome is similar to how opening the economy reduces mark-ups in models with heterogeneous firms, for instance Melitz and Ottaviano (2008).

The equilibrium number of sellers can be found by combining (2.21) and (2.24) and solving the two equations \((l=H,F)\) for \(m^l\):
Comparing with (2.13), it is ambiguous whether the number of sellers falls or increases when the economies are opened. Import competition tends to squeeze sellers out, but it may be that the domestic price posting expenditure falls sufficiently to allow the number of sellers to increase in both countries. In itself, the number of sellers has no implications for welfare, what matters is the total number of buyers reached by their price posting campaigns.

Sellers all expect the same profit on the export market, but sellers setting higher export prices export less in expected terms and are more likely not to carry out any export sales at all. The pattern is again similar to models of trade with heterogeneous firms, where less productive firms tend to export less or not at all. Moreover, my model rationalizes a feature of firms’ export behavior that these models have a hard time catching: As laid out in Eaton, Eslava, Krugler and Tybout (2007), many firms export only small quantities and very infrequently. Such behavior is peculiar if these firms have invested large resources in exporting, but it comes out naturally in my model: Once in a while, sellers with high prices are lucky enough to reach a foreign buyer who has no better offer available.

2.3.2 Trade and Welfare

Welfare in the open economy is found by replacing the relevant terms in (2.14) by their open economy counterparts.

**Corollary of proposition 4:** Gains from trade

Welfare in the open economy is given by

\[ W^I = n^I (\bar{p} - c) \left( 1 - \exp(-\lambda^I (\lambda^I + 1)) \right). \]  

(2.26)

The increased contact frequency leads to higher welfare in the open economy. The intransparency loss, \( \exp(-\lambda) (\lambda + 1) \), is reduced, raising welfare towards the Bertrand level \( n^I (\bar{p} - c) \).

The rise in welfare from the increased contact frequency captures two effects: Buyers benefit both from having more offers to select among (increase in \( \lambda^I \)) and from the lower prices now offered (downward shift in \( F(p) \)).
This novel gain from trade, which I have dubbed the intransparency gain, can be quantified. Figure 2 depicts the intransparency loss, \( \exp(-\lambda^l) (\lambda^l + 1) \), as a function of the contact frequency \( \lambda^l \). When the closed economy value of \( \lambda^l \) is small, even if international trade only brings a modest increase in \( \lambda^l \), the resultant transparency gain is high. On the other hand, welfare cannot rise over the Bertrand level. When buyers on average receive six offers, the market is only 2% from the Bertrand equilibrium. Economies, markets or sectors where the contact frequency already was high in the closed economy (for instance due to a large number of buyers, as seen from (2.12)), have lower transparency gains from trade.

### 2.4 Discussions and Perspectives

The new motive for intra-industry trade outlined in this paper is therefore not omni-present: When buyers already have good information on sellers' offers, there is little revenue for potential foreign sellers to reap, and export price posting may not take place at all. Moreover, some markets have institutions that ensure full information to buyers, notably the futures exchanges where many commodities, such as unprocessed metals and the main crops, are sold. The model presented outlines one of the benefits of such institutions, they remove the intransparency loss and the need to spend resources on price posting.

The transparency gain from proposition 4 is a result of the changed strategic reactions of sellers: The open economy offers a broader strategic scope with the possibility of posting prices abroad, but also tougher competition, since buyers now on average have a larger choice set, leading to more aggressive pricing strategies. Arising from strategic interactions, the transparency
gain is more closely related to the "competition gain" in the Cournot models of intra-industry trade presented in Brander (1981) and Brander and Krugman (1983). In these models, opening for international trade leads to reciprocal dumping, firms in both countries export their good. The present model may be regarded as a homogeneous good Bertrand counterpart to Brander and Krugman's Cournot model, although the mechanisms at play are rather different.  

Trade may be facilitated through lower cost of price posting abroad, represented by a downward shift in $v_x(k^l/n^h)$. There are two effects of such a shift, they can be thought of as substitution and income effects, and their relative importance depends on how price posting costs change. For illustration, suppose export price posting costs are reduced proportionally, to $\alpha v_x(k^l/n^h)$, with $0 < \alpha < 1$. The relation between domestic and export price posting is changed to

$$v(k^l/n^l) = \alpha v_x(k_x^l/n^h)$$

which clearly implies an increase in export price posting (the substitution effect), while the zero profit condition, (2.22) now reads

$$k^l/n^l = \frac{v(k^l/n^l) + f_x + \alpha v_x(k_x^l/n^h) - v_x(k^l/n^h)(k^l/n^h)}{v_x(k^l/n^l)}.$$  

With lower export price posting costs, there is profit potential for new sellers to enter, the income effect is swallowed up by entry. Moreover, the new entrants force each seller to reduce her domestic price posting. Both the income and substitution effects hence decrease $k/n^l$, and by proposition 4 the net implication is an increase in $\lambda l$ and therefore welfare gains.

This comparative statics exercise provides an additional insight: It is plausible that in countries sharing a language or having similar cultures, foreign price posting costs $v_x$ will be closer to domestic costs $v$, and therefore

16 There is another model of intra-industry trade in a homogeneous good Bertrand setting, due to Cukrowski and Aksen (2003). Trade is here driven by uncertain demands in both market and brings with it a "diversification gain", as risk-averse firms can reduce their risk exposure by serving both the domestic and the export market. As sellers' realized sales in my model are stochastic, serving both markets also brings reduced revenue variance. Being risk-neutral, however, sellers do not value this. Stretching the interpretation of their model a bit, Cukrowski and Aksen (2003) show a result regarding incomplete information similar to this model: The driver of intra-industry trade is incomplete information, and, as in my model, improved flows of domestic market information is a detriment to trade.
trade and the gains thereof will be higher. The analysis of this paper thus presents an explicit channel for the well-known empirical result that countries with similar languages trade more, see for instance Melitz (2008).

The IT revolution of the last two decades has provided sellers with a cheap price posting device, which does not require any physical proximity to buyers. In terms of the model, the ascent of the internet represents a reduction in both $v$ and $v_x$, with the reduction in $v_x$ likely being more pronounced. It is not certain, however, that the internet will promote trade. Comparative statics allow for the possibility that the drop in $v$ is sufficient to remove the motive for export price posting. However, if $v_x$ drops from a prohibitive level and approaches $v$, intra-industry trade is likely to increase. This pattern seems to apply to the markets for books and compact discs, which prior to the internet were dominated by local retail sales.

Recent research in international trade, with Antras, Garicano and Rossi-Hansberg (2006) and Grossman and Rossi-Hansberg (2008) as prominent examples, has highlighted how improved information technology enables firms to internationalize organization and production processes. This paper suggests that IT may also impact trade flows more directly by facilitating extra-firm exports.

2.4.1 Quality Differences

A natural extension of the model is to allow for vertical quality differences. The model is then able to describe a much larger set of industries, now including for example domestic appliances, household electronics, computers and other office machinery, as well as standardized production machinery and intermediates (common chemicals, for instance). The key characteristics of such industries are: Goods are not tailored to fit a particular buyer's taste or needs; goods may represent a significant share of a buyer's income; and goods are to some degree experience goods, quality differences are typically hard to assess completely before purchase.

The broader interpretation of prices also calls for a reinterpretation of buyer behavior and advertising activities. Since these goods are relatively expensive for the buyers, it is worthwhile for the buyers to actively search for offers. The time costs of searching for offers on light bulbs or tumble dryers are presumably more or less equal, but the cost of buying the first, the best light bulb is much lower. A natural assumption is therefore that in a quality-adjusted price-interpretation of the model, all sellers' prices are known to buy-
ers. What buyers cannot know is their reservation price of a particular offer, and this is why sellers must advertise, otherwise buyers will not buy the goods.

Advertising in these industries often contains no information on price. The literature on experience goods and signaling, with Nelson (1970, 1974) and Milgrom and Roberts (1986) as key contributions, has interpreted advertising in this context as credible signals of quality characteristics that buyers cannot verify before purchase. Reinterpreting for my model, advertising now enables buyers to determine their willingness to pay for a particular offer.\(^\text{17}\)

If a buyer sees an advertisement from only one seller, he will purchase this seller's good if the sales price is lower than his newly computed willingness to pay. If he sees several advertisements, he will purchase the good from the seller that offers the highest difference between reservation price and sales price.

The aim here is not to develop a full-fledged model, but to show how it may be constructed. I therefore do not dwell on why sellers produce at different quality levels; they simply do, for some exogenous reason. I consider a fixed number of sellers rather than free entry.

A necessary assumption to retain the predictions of the homogenous good case is that the cost of quality is proportional to its value: When a good has quality \(\theta\), it implies that the buyer's willingness to pay for the good is \(p\theta\) and that the marginal cost of producing the good is \(\theta c\). A seller producing with quality \(\theta\) has expected profits of

\[
\pi(p,k',p_x,k_x',\theta) = Q'(p,\theta)(p-\theta c)k' + Q^h(p_x,\theta)(p_x-\theta c)k_x^c \\
- \nu(k'/n',\theta) - \nu_x(k_x^h/n^h,\theta) - f_x(\theta)
\]

where the costs of advertising may vary with quality.\(^\text{17}\)

A buyer selects the offer observed that offers the lowest quality adjusted price, defined as \(p/\theta\). The purchase probability can be derived as in (2.7), \(Q'(p,\theta) = \exp(-\lambda F(p/\theta))\), and sellers will still randomize their price, with \(\theta\) as the highest price charged. The condition that any price, which a seller with quality \(\theta\) charges, must make the same expected profits as charging \(\theta\) is

\[
\exp(-\lambda F(p/\theta))(p-\theta c) = \exp(-\lambda)(\theta\bar{p} - \theta c).
\]

\(^{17}\) My model abstracts from heterogeneity in buyers' preferences for quality, which is a key issue in the mentioned literature.
The cumulative distribution of quality-adjusted prices follows:

\[ F'(p/\theta) = 1 - \frac{1}{\lambda^l} \ln \left( \frac{p - c}{p/\theta - c} \right). \] (2.27)

The optimal pricing strategy is to raise the price proportional to the quality of the good and then randomize according to (2.27). International trade increases \( \lambda^l \), pushing the price/quality trade-offs offered to buyers downwards, with prices approaching the marginal cost of quality.\(^{18}\)

Naturally, one can think of more sophisticated purchase processes, with buyers inferring or learning the good's quality through repeated exposure to advertisement, peer effects or observed sales. Advertisement may spill over across borders, perhaps enabling some sellers to create an international brand for their good. A particular seller may exploit his brand by expanding his product range (see Choi (1998)), giving a demand-side angle for the emergent literature of multi-product firms in international trade. Some countries may end up being perceived as providing superior quality for particular goods (French wine, German machinery, etc.). This paper hopefully provides a framework for further work on these issues.

Per unit trade costs have been left out so far in order to simplify the exposition. Conceptually, they fit in nicely as supplementary costs of delivering the good to foreign buyers. Whenever a seller has a higher marginal cost, her incentive to undercut other sellers will be weaker. The implication is that the equilibrium price distribution will split in two, with foreign sellers pricing in the upper part of the distribution and domestic sellers in the lower part. This prediction, although somewhat extreme, is more in line with firms' export pricing than the customary iceberg cost of exporting: Firms raise their f.o.b. price when exporting to distant markets.\(^{19}\)

The "knife-edge" prediction, where the price distribution splits in two, is also the reason behind the above assumption that quality affects willingness to pay and costs proportionally. Interplays between quality differences and trade costs would allow for less stark predictions, such as Alchian-Allen effects:

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\(^{18}\) The optimal number of buyers to advertise to will vary with the quality offered, but does not vary with the price charged.

\(^{19}\) The iceberg cost assumption is that for one unit to arrive at the export destination, \( r > 1 \) units must be shipped, the remaining \( r-1 \) units "melt away" during transit. This assumption leads to the erroneous prediction that firms' f.o.b. prices will either be lower on the export market or equal to the domestic price. See Martin (2009) for derivations and empirical documentation.
only high-quality products are worth exporting. Allowing sellers to have different marginal costs due to productivity differences would also lead to a further partitioning of the price distribution, and under certain conditions, only productive sellers would export.

2.4.2 Empirical Considerations

Even though the proposed model has clear and testable empirical predictions, the data requirements are substantial. One would need price data at the seller level, and ideally a natural experiment of reduced advertisement costs. The studies of pricing by online bookstores by Clay et al. (2001) and Clay et al. (2002), and of retailers vs. online sellers of books and CDs by Brynjolfsson and Smith (2000) come close to meeting these conditions. Their findings seem in line with the predictions of the present paper. The internet has not led to perfect convergence of prices, price dispersion remains and it cannot be related to differentiation: There are smaller sellers setting prices higher than amazon.com. Unfortunately, none of the papers report how price dispersion evolves over time.

With the increasing availability of scanner data (see Feenstra and Shapiro (2003)), the prospects of formally testing the model are good. Moreover, there is a shortcut to evaluating the importance of market intransparency and indirectly test the model: A strong point in the model is that to evaluate welfare relative to the Bertrand level, one only needs to know the parameter $\lambda'$. 

$$\frac{W^l}{n l^l (p - c)} = \left(1 - \exp(-\lambda') (\lambda' + 1) \right).$$

Data on the average number of offers a buyer receives are not available through traditional data sources, but if buyers of a given product can be identified, it is straightforward to survey them on how many alternative offers they considered before purchase. In computing an estimator of $\lambda$, one must take into account the $\exp(-\lambda') n l^l$ potential buyers that did not receive any offer and therefore cannot be sampled, but this correction should not pose any major problems. A low estimate of $\lambda$, compared to the number of sellers, would in itself provide support for intransparent markets.
2.5 Conclusion

This paper has demonstrated that the relations between information costs and international trade are not as simple as one might expect: Information costs do not always reduce trade flows between countries. The case treated in this paper, advertising costs, may in fact generate international trade. The more costly advertising is, the less advertising is done by domestic sellers, leaving more profit potential for foreign sellers. International trade mitigates the problem of incomplete information and increases welfare.

The framework outlined here applies to any industry where goods are not tailor-made for individual buyers and where there is no market institution that resolves the information problem, such as a futures exchange. Moreover, many of the stylized facts in international trade that can be generated with heterogeneous firms models are replicated in the present framework, even though sellers are initially identical. With its explicit treatment of information flows, the model predicts that countries with similar languages will trade more, and it shows how improved information technology may boost international trade.

Appendix A:
Proof of proposition 1:
Continuity of $F(p)$ implies that the distribution has no mass points. Therefore, there is no pure strategy equilibrium where all sellers offer the same price. To see this, first observe that if all sellers offer the same price, the probability $q$ that a buyer accepts the seller's offer among $x$ other offers is $1/(1+x)$. The probability of making a sale is therefore

$$Q(p) = \sum_{x=0}^{\infty} \left( \frac{1}{1+x} \right) e^{-\lambda} \frac{x^x}{x!} = \frac{1}{\lambda} \sum_{x=0}^{\infty} e^{-\lambda} \frac{x^{x+1}}{(x+1)!} = \frac{1}{\lambda} \sum_{x=1}^{\infty} e^{-\lambda} \frac{x^x}{x!} = 1 - e^{-\lambda/\lambda} = 1 - e^{-1} < 1$$

(The result, proven below that all sellers contact the same number of buyers also holds in this case)

Therefore, a seller can do strictly better by decreasing her price with $\varepsilon$ and being certain that her offer is accepted, $k(p - \varepsilon - c) > kQ(p)(p - c)$ for $\varepsilon$ sufficiently small. If all firms were to offer $p = c$, one firm could instead offer $p = \bar{p}$ and earn positive expected profits, since the probability that this is the only offer a consumer receives is $e^{-\lambda} > 0$.

A similar argument rules out any equilibrium where some strictly positive fraction of sellers set the same price, establishing continuity of $F(p)$. Connectedness follows from the fact that a gap, say between $p'$ and $p''$, with $p' < p''$, ...
would lead to the contradiction \( \pi(p,F(p)) > \pi(p',F(p')) \) for all \( p \in (p', p'') \), since \( F(p') = F(p'') \).

The upper support must be equal to \( \bar{p} \): if a seller is certain that no higher price will be posted, she can only sell the good if the buyer receives no other offer. If a buyer receives no other offer, the seller earns the most by offering \( p = \bar{p} : \arg \max_{p \leq \bar{p}} \pi(p,1) = \arg \max_{p \leq \bar{p}} k e^{-\lambda} (p - c) = \bar{p} \). It is never profitable to offer a price lower than \( c \), as long as sellers make non-negative profits, the lower bound will be larger than \( c \).

**Proof that \( k_j = k \), all sellers contact the same number of buyers:**

Any \( (p_j, k_j) \) pair offered must give the same profit. Specifically, it must hold that \( \pi(p_j, k_j) = \pi(\bar{p}, \bar{k}) \), where \( \bar{k} \) is the optimal number of contacts when offering \( \bar{p} \). Inserting (2.4) in this condition gives

\[
 v'(k_j/n)(k_j/n) - v'(k_j/n) = v'(\bar{k}/n)(\bar{k}/n) - v'(\bar{k}/n) .
\]

Differentiating the left-hand side with respect to \( k_j/n \) gives \( v''(k_j/n)(k_j/n) \), which is positive when \( k_j/n > 0 \). The function \( f(k/n) = v'(k/n)(k/n) - v(k/n) \) is monotonously increasing for \( k_j/n \) positive. It follows that \( k_j = k \): In equilibrium all sellers contact the same number of buyers, and this optimal number of contacts does not depend on the prices they offer.

***

**Calculating \( E_b(p) \), the expected price that buyers pay:**

The purchase probability, \( Q(p) \), calculated in (2.7) denotes the probability that all offers that a buyer receives have prices equal to or greater than \( p \). The complementary event that at least one price is lower than \( p \) has probability

\[
 Pr(\text{at least one offer has price lower than } p) = 1 - Q(p) = 1 - e^{-\lambda} \frac{\bar{p} - c}{p - c} .
\]

The probability of receiving no offer is equal to \( e^{-\lambda} \).

If the buyer has received an offer lower than \( p \), it means that the price he paid for the good, call it \( p_{\text{paid}} \), is no lower than \( p \):

\[
 p_{\text{paid}} = p\]
\[
\Pr(P_{\text{paid}} \leq p) = 1 - e^{-\lambda \frac{p - c}{p - c}}
\]

This probability gives the cumulative distribution of the price buyers pay, call it \(F_b(p)\):
\[
F_b(p) = 1 - e^{-\lambda \frac{p - c}{p - c}}
\]

As buyers getting no offers receive no buyer surplus and therefore in welfare terms are equivalent to buyers paying \(\bar{p}\), the cumulative distribution has mass point \(\Pr(P = \bar{p}) = e^{-\lambda}\). The corresponding density is given by
\[
f_b(p) = 1 - e^{-\lambda \frac{p - c}{p - c}} \frac{1}{(p - c)^2}, \text{ and } f_b(\bar{p}) = e^{-\lambda}.
\]

\(E_b(p)\) can now be computed:
\[
E_b(p) = \int_{e^{-\lambda} + (1 + e^{-\lambda})c}^p pf_b(p)dp + e^{-\lambda} \bar{p} = e^{-\lambda} (\bar{p} - c) \int_{e^{-\lambda} + (1 + e^{-\lambda})c}^p \frac{p}{(p - c)^2} dp + e^{-\lambda} \bar{p}.
\]

Integrating by parts gives:
\[
E_b(p) = e^{-\lambda} (\bar{p} - c) \left[ \frac{-\bar{p}}{\bar{p} - c} - \left( e^{-\lambda} \bar{p} + (1 + e^{-\lambda})c \right) \frac{(-1)}{e^{-\lambda} (\bar{p} - c)} \right]
\]
\[
- \int_{e^{-\lambda} + (1 + e^{-\lambda})c}^p \frac{p}{(p - c)^2} dp + e^{-\lambda} \bar{p}.
\]
\[
= e^{-\lambda} \bar{p} + (1 - e^{-\lambda})c - e^{-\lambda} \bar{p} + e^{-\lambda} (\bar{p} - c) \left[ \ln(\bar{p} - c) - \ln(e^{-\lambda} (p - c)) \right] + e^{-\lambda} \bar{p}
\]
\[
= (1 - e^{-\lambda})c + e^{-\lambda} \bar{p} + \lambda e^{-\lambda} (\bar{p} - c)
\]
\[
= c + e^{-\lambda} (\bar{p} - c)(\lambda + 1)
\]

**References**


3 Antidumping with Heterogeneous Firms

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April 2011

Abstract:
This paper analyzes antidumping (AD) policies in a two-country model with heterogeneous firms. One country enforces AD so harshly that firms exporting to the country choose not to dump. In the short run, the country enforcing AD experiences reduced competition to the benefit of local firm and detriment of local consumers, but in the long run AD protection attracts new firms, increasing competition and consumer welfare. In the country’s trading partner, competition initially increases: Some firms give up exporting, but those that remain will lower their domestic prices. Consumers therefore benefit in the short run. In the long run, however, fewer firms will enter the unprotected country, and competition will eventually decrease, resulting in welfare losses.

Keywords: Trade policy, antidumping, monopolistic competition, heterogeneous firms

JEL-codes: F12, F13

This essay is currently under revise and resubmit at Economie Internationale
3.1 Introduction

With Melitz (2003) as the seminal paper, models of monopolistic competition with heterogeneous firms have become one of the most prominent frameworks in international trade, for both theoretical and empirical research. So far, however, trade policies have received only a rather crude treatment in the framework, trade liberalizations are invariably reduced to fewer exported goods disappearing in transit (lower "iceberg costs" of exporting). This paper will mend this gap by examining how antidumping policies may affect an economy with heterogeneous firms.

The motivations for picking antidumping (AD) as the particular policy to treat theoretically are clear. As Zanardi (2006) documents, the number of countries with AD legislation rose from 37 in 1980 to 98 in 2003, and the number of annual investigations more than doubled over this period, whereas tariffs have been steadily declining. The results of Vandenbussche and Zanardi (2008) even indicate that countries replace regular tariffs with AD. All this points to AD as a trade policy of rising importance. Moreover, Konings and Vandenbussche (2008, 2009) document that responses to AD are firm-specific, warranting theoretical investigations at the firm-level.

The theoretical results of this paper are derived in the two-country model of Melitz and Ottaviano (2008), introduced in section 3.2.1 and 3.2.2. To disentangle how both countries in the two-country model are affected by one country's AD policy, a unilateral AD regime is analyzed, where one country (Foreign) has AD legislation, whereas the other country (Home) has not.

The specific AD regime analyzed is what we may call a "credible threat" policy regime: The risk and costs of an AD petition are large enough that all firms exporting to Foreign choose to behave in a manner where they avoid infringing with the AD legislation. Although such a scenario admittedly is extreme, Vandenbussche and Zanardi (2010) find that threat effects of AD are quite real for countries that use AD extensively. From a theoretical perspective, the credible threat scenario also has the advantage that it makes AD policies resemble changes in the iceberg cost parameter, allowing a direct comparison and an assessment of how good the iceberg approximation may be.

In this scenario, firms in Home that wish to export must price such that they cannot be found guilty of dumping by Foreign's AD authorities, they must subject to a "no-dumping constraint". As outlined in section 3.2.4, this constraint will make exporting firms cut their domestic price to be able to set a
lower export price. The further results in the paper are consequences of this altered pricing behavior. For exporters that earn relatively little export profits, it may be more profitable to stop exporting altogether. A first benefit of the heterogeneous firms framework is this result on how AD affects export selection in slightly more subtle ways than an iceberg cost does, section 3.2.5 provides the details.

The immediate consequences of Foreign's AD regime are analyzed in section 3.2.6. Because the firms in Home that still export reduce their domestic price, competition increases in Home, and the least productive firms there may wish to temporarily shut down production. In Foreign, the reduced imports mean that all firms increase domestic production and profits. Consumers in Home gain, while consumers in Foreign lose.

When Foreign's AD policy is permanent, however, this situation will not endure: It is profitable for new firms to enter Foreign's protected market, and less attractive to set up a firm in Home. Section 2.7 analyzes what happens in the long run, after these changes in entry patterns have taken place. In Foreign, new entrants will more than compensate for the lower imports from Home. Competition will increase, driving average productivity up and bringing welfare gains to Foreign's consumers. In Home, fewer firms will enter, competition will decrease as will average productivity, and home's consumers will suffer welfare losses.

The heterogeneous firms framework enables us to track how the effects of Foreign's AD regime depend on how productive firms are: In Foreign, all firms benefit in the short run from reduced domestic competition, but the firms that are productive enough to export actually lose on their export market. These results are resemble Konings and Vandenbussche (2009)'s empirical findings. In the long run, however, the predictions are exactly reversed: The exporting firms benefit from lower competition in Home, whereas weaker firms are worse off because of the increased domestic competition. In Home, exporters lose both in the short and the long run, but while unproductive firms suffer in the short run, this type of firms benefit from reduced competition in the long run.

Section 3 discusses wider implications of the analysis. I first compare the effects of AD policy to customary modeling of trade restrictions: although the long-run effects are similar, AD hurts the trading partner somewhat less, because the exporters to an AD regime will lower their domestic prices. I afterwards consider what policy implications it might have that countries have a unilateral incentive to enforce AD. One could fear a scenario where all coun-
tries enforce AD against each other, but empirical studies suggest that we are currently not in that situation, only some countries enforce AD heavily.

Although this paper is the first to show how AD may lead to welfare gains in the long run, it is in order to discuss whether some of the results derived here could be obtained in other models, which I do by the end of section 3.3.20

3.2 A Model of Antidumping with Heterogeneous Firms

3.2.1 Demand and Production

The starting point of the analysis is the two-country model of Melitz and Ottaviano (2008), I begin by briefly introducing the model's central mechanisms. Consider two countries, Home (H) and Foreign (F). There are $L_l$ representative consumers in country $l=H,F$, each supplying one unit of labor. Utility for the representative consumer is:

$$U = q_0^{c} + \alpha \int_{i \in \Omega} q_i^{c} di - \frac{1}{2} \gamma \int_{i \in \Omega} (q_i^{c})^2 di - \frac{1}{2} \eta \left( \int_{i \in \Omega} q_i^{c} di \right)^2$$

(3.1)

The numeraire good $q_0^{c}$ is supplied at constant returns to scale with perfect competition and traded costlessly, wages in both countries are therefore fixed at unity. $\Omega$ is the set of possible varieties of the differentiated good, where $q_i^{c}$ indicates quantity consumed of variety $i$. $\alpha$ and $\eta$ determine the size of the differentiated goods industry compared to the numeraire industry, $\gamma$ governs the degree of differentiation between varieties.

The demand for variety $i$ in country $l$, resulting from the $L_l$ representative consumers' utility maximization subject to the budget constraint $q_0^{c} + \int_{i \in \Omega} p_i q_i^{c} di \leq 1$, is

20 The typical theoretical treatment of AD is rather unrelated to the analysis here, and makes use of partial equilibrium models to examine how firms' strategic interactions are affected by AD. Examples are Prusa (1992), Prusa (1994), Reitzes (1993), Pauwels, Vandenbussche and Weverbergh (2001). Haaland and Wooton (1998)'s analysis of "AD jumping FDI" does have some implications that are similar to the firm reallocation results of the present paper.
\[ q_i = L' q_i^* = \frac{\alpha L'}{\gamma + \eta N^i} - \frac{L'}{\gamma} p_i^* + \frac{\eta N^i}{\gamma + \eta N^i} \frac{L'}{\gamma} \bar{p}^*, \]  
(3.2)

where \( p_i^* \) is the variety's price, \( N^i \) is the number of firms operating in market \( l \), and \( \bar{p}^* = \left( \frac{\int p_i dt}{N^i} \right) \) is the average price of varieties on the market. With the linear demand, there is a 'choke price' on a market, for which demand for a given variety is zero:

\[ p^* = \frac{1}{\gamma + \eta N^i} \left( \gamma \alpha + \eta N^i \bar{p}^* \right) \]

To set up a firm, a fixed entry cost \( f_E \) must be paid, which is thereafter sunk. The entering firm then learns its marginal cost \( c \), drawn from the Pareto distribution \( G(c) = (c/c_M)^k \) (\( c_M \) is the maximal cost draw, \( k \) is the Pareto shape parameter). The firm may thereafter produce with cost function \( C(q) = cq \). The "domestic cost cutoff" in country \( l \),

\[ c^i_D = \frac{1}{\gamma + \eta N^i} \left( \gamma \alpha + \eta N^i \bar{p}^* \right) \]

(3.3)

is the cost draw that is so high that a firm with this marginal cost will sell zero units if it sets price equal to marginal cost. A firm with cost draw higher than \( c^i_D \) will not be able to cover its marginal costs and exits immediately upon entry. Since \( f_E \) is sunk, any firm with \( c < c^i_D \) will serve its domestic market.\(^{21}\)

The domestic cutoff is the endogenous variable around which the model revolves. As outlined in section 3.2.6 below, free entry will determine its long-run solution. The more firms that operate in a market, the lower the cutoff will be, because more firms will have been fortunate enough to obtain a low marginal cost. A lower average price also leads to a lower cutoff. Both of these determinants increase competition, and \( c^i_D \) therefore indexes the degree of competition in country \( l \). With the Pareto distributed marginal costs, the do-

\(^{21}\) It is instructive to view \( c^i_D \) as the "height" of the demand curve that every firm faces. This visualization makes it obvious that a firm with marginal cost higher than the cutoff cannot operate profitably, and it is intuitive why we may want to summarize the two channels of increased competition (more firms or a lower average price) by their combined effect on each firm's residual demand.
mestic cutoff is also proportional to the average productivity of the firms operating, and it therefore also summarizes a country's competitiveness.

### 3.2.2 Exporting and Pricing without Antidumping

Even without any AD policies, export of the varieties is costly. In order for one unit of a variety to arrive abroad, \( \tau^l > 1 \) units must be shipped. The marginal cost for a firm in \( l \) of exporting a good to \( h = H,F, h \neq l \) is therefore \( \tau^l c^h \). The iceberg cost \( \tau^l \) is country-specific, it may be more costly to export from Home to Foreign than the other way round. In addition to capturing geographical barriers, \( \tau^l \) is also a variable that country \( l \) to some degree can change through other trade policies.

Some firms will be unable to cover marginal costs of exporting. The "export cost cutoff", the cost draw for which a firm will sell zero units abroad, is defined as

\[
c^l_X = \frac{c^h_D}{\tau^h}. \tag{3.4}
\]

The \( X \) subscript is used to designate any "export variable". Without other trade restrictions than the iceberg cost, all firms with cost draws equal to or lower than \( c^l_X \) will export.

When setting prices, firms solve the problem

\[
\max_{p_D', p_X'} \pi^l(p_D', p_X') = \pi^l_D(p_D') + \pi^l_X(p_X').
\]

The profit-maximizing prices and corresponding quantities of a firm's domestic and export market can be expressed using the cutoffs, as:

\[
p^l_D(c) = \frac{1}{2}(c_D' + c), \quad p^l_X(c) = \frac{\tau^h}{2}(c_X' + c) \tag{3.5}
\]

\[
q^l_D(c) = \frac{L^l}{2\gamma}(c_D' - c), \quad q^l_X(c) = \frac{L^h}{2\gamma}(c_X' - c). \tag{3.6}
\]
Optimal prices are increasing functions of the firm's marginal cost, \( c \), quantities a decreasing function. From (3.5), it holds that \( p^D_D(c) > p^l_X(c) / \tau^h \), as \( c^l_D < c^l_X \). 22

The intuition for this "reciprocal dumping" result, also derived in Brander and Krugman (1983), is straightforward: Whenever demand is "less than iso-elastic", that is, if the price elasticity increases when the price rises, firms will want to bear some of the costs of exporting themselves rather than passing it on to consumers, in order to mitigate the declining demand of a higher price.

Reciprocal dumping is a natural result of firms' optimal pricing, but AD legislation may bring firms following this strategy into trouble: The authorities, who examine whether dumping occurs, typically deduct trade costs from the export price in order to achieve "factory gate prices". In this model, any exporting firm can therefore be found to be dumping. 23

Prices and quantities give rise to profits of

\[
\pi^l_D(c) = \frac{L^l}{4\gamma}(c^l_D - c)^2, \quad \pi^l_X(c) = \frac{L^h}{4\gamma}(\tau^h)^2(c^l_X - c)^2
\]  (3.7)

Naturally, a firm only operates on a market if it has non-negative profits there. All firms operating on market \( l \) have lower profits if the domestic cutoff \( c^l_D \) is reduced, another manner in which the domestic cutoff summarizes competition.

### 3.2.3 The Analyzed Antidumping Scenario

I now turn to how the economies are affected by AD policies in Foreign, and the behavior of the AD authority and firms' reactions to it must therefore be

---

22 The export cutoff must be lower than the domestic cutoff in an equilibrium where both countries produce varieties of the differentiated good. See appendix A.4 in Melitz and Ottaviano (2008).

23 To document that firms indeed are dumping according to the "factory gate" definition of comparable prices, AD authorities would need detailed data of domestic and export prices, firms' costs and all relevant trade costs. Contrary to economic researchers, AD authorities can typically directly gather price data. They will request the remaining information from the accused firms, but a lot of data is constructed by more or less educated guesswork. It is well documented, see for instance Blonigen (2006) and Bown and Prusa (2010), that data collection and interpretation is biased towards finding firms guilty of dumping.
specified. I choose to analyze a "credible threat" scenario, where firms in Home perceive the expected costs of an AD petition and subsequent tariffs as so high that they decide not to risk any infringement. One can think of a situation in which AD petitions have been frequent and costly over an extended period. The firms in Home that export to Foreign therefore set their prices in such a manner that they cannot be accused of dumping.

Such a scenario is admittedly extreme, but threat effects of AD have empirical support: Vandenbussche and Zanardi (2010) find that for countries that use AD legislation intensively, imports that are not directly affected by AD investigations or tariffs (for instance from third countries) also fall. Moreover, the analyzed regime may be interpreted as evaluating Foreign's AD legislation literally: it is the kind of behavior that the AD legislation is trying to induce. Finally, the credible threat scenario has common points with changes in the iceberg cost, which makes subsequent comparisons easier: Threat effects are permanent, they affect all exporting firms, and there is no tariff revenue to redistribute.

### 3.2.4 Pricing Under Antidumping: Domestic Distortion

In monopolistic competition models, firms are non-strategic and do not act in anticipation of other firms' reactions. By assumption, the only firms that react directly to Foreign's AD regime are therefore exporting firms in Home, called "Home exporters". Firms in Foreign and firms in Home that do not export will therefore still have prices, quantities and profits according to (3.5), (3.6) and (3.7).

As assumed, firms in Home that consider exporting, all perceive the risk and costs of AD petitions as so high that they choose not to dump. Because AD authorities in Foreign deduct trade costs from export prices in order to compare "factory gate prices", $p_D^H$ vs. $p_X^H / \tau^F$, Home exporters, wishing to avoid AD investigation, must pass export costs fully through to consumers in Foreign. The optimization problem that led to prices (3.5) therefore now becomes subject to a "no-dumping" constraint:

$$\max_{p_D^H, p_X^H} \pi_D^H(p_D^H, p_X^H) = \pi_D^H(p_D^H) + \pi_X^H(p_X^H)$$

subject to $p_X^H \geq \tau^F p_D^H$

Because of the constraint, the choices of domestic and export prices are now interdependent for a Home exporter: If the firm lowers its domestic price,
it can also lower its export price proportionally without any risk of being caught, because "factory gate prices" remain identical. (In optimum, the "no-dumping constraint" will bind, $p^H_X = \tau^F p^H_D$. Result 1 formalizes this intuition, with an $A$ subscript denoting optimal choices in the AD scenario:

**Result 1: Optimal Domestic Distortion**

In the antidumping scenario, the optimal pricing strategy for an exporting firm is to set domestic and export prices as

$$p^H_{DA}(c) = \frac{1}{2} \left( \beta^H c^H_X + (1 - \beta^H) c^H_D + c \right),$$

$$p^H_{XA}(c) = \frac{\tau^F}{2} \left( \beta^H c^H_X + (1 - \beta^H) c^H_D + c \right),$$

where

$$\beta^H = \frac{L^F (\tau^F)^2}{L^F (\tau^F)^2 + L^H} = \frac{1}{1 + \frac{L^H}{L^F (\tau^F)^2}}, \quad \beta^H \in (0,1) \quad (3.9)$$

An exporting firm seeking to avoid the risk of AD petitions will find it optimal both to raise its export price and reduce its domestic price.

An exporting firm that will not dump can no longer set optimal prices independently in each market. The optimal domestic and export prices now involve a weighted average of domestic and export market conditions, $c^H_X$ and $c^H_D$. This weighting is governed by $\beta^H$, an index of the relative importance of the export market for the Home firm. The larger Foreign is relative to Home, the more weight will be given to setting an optimal export price rather than an optimal domestic price. The export cost $\tau^F$, which does not relate to AD, has a slightly less intuitive effect on pricing: The higher the export cost, the more the firm will lower its domestic price. The firm wants to absorb some of the trade cost, but can only do so by reducing its domestic price. As a result, a higher non-AD export cost brings the firm closer to its optimal export price.

The remaining results of this paper will follow from result 1, and dwelling upon it is therefore worthwhile. Before discussing whether domestic distortion is realistic in practice, let us examine some of its theoretical consequences. The optimal AD prices (8) lead the exporting firm in Home to sell quantities
under the AD regime. The firm earns profits of

\[ \pi^H_{DA}(c) = \frac{L^H}{4\gamma} \left( (c^H_D - c)^2 + \left( \beta^H \right)^2 (c^H_D - c^H_X)^2 \right) \]

and

\[ \pi^H_{XA}(c) = \frac{L^F}{4\gamma} \left( (c^H_X - c)^2 + \left( 1 - \beta^H \right)^2 (c^H_D - c^H_X)^2 \right). \] (3.11)

Compared to a world without antidumping, (3.6) and (3.7), quantities increase on the domestic market as function of the lower price, and decline on the export market. Profits are smaller on both markets (constrained maximization can never give higher profits than unconstrained maximization), but the welfare implications for consumers are opposite:

In Home, the profit loss is pro-competitive, reducing consumers' deadweight loss: Consumers in Home benefit from the lower domestic prices that Home exporters set to avoid raising the export price. In Foreign, on the other hand, the profit loss is anti-competitive: Foreign's consumers face higher import prices, buy less, and their consumer surplus is reduced beyond the monopoly level. The higher \( \beta^H \), that is, the larger Foreign relative to Home or the higher the "regular" trade cost \( \tau^F \), the larger will be the gains in consumer surplus in Home and the lower will be the consumer surplus reductions in Foreign. A small country loses less from its trading partner's AD enforcement, a large country loses less by enforcing the AD policy.

The welfare valuation of these shifts in deadweight losses will depend on how substitutable varieties are. Consider the indirect utility function corresponding to (3.1),

\[ U^i = 1 + \frac{1}{2} \left( \eta + \frac{\gamma}{N^i} \right)^{-1} \left( \alpha - \bar{p}^i \right)^2 + \frac{1}{2} \frac{N^i}{\gamma} \sigma^2_{p,i}, \] (3.12)

where \( \sigma^2_{p,i} \) is the price variance. For a given average price, if the price variance is higher, some varieties are cheaper, and consumers can get more total
consumption by buying more of these. The consumer's willingness to substitute expensive varieties for cheap ones decreases with \( \gamma \); the higher \( \gamma \) is, the more the consumer values variety. The AD regime raises the price variance in Home and lowers it in Foreign. When varieties are good substitutes, the consumers in Home benefit more from Foreign's AD policy and Foreign's consumers lose less.

3.2.5 Export Selection to the Antidumping Regime

The reduction in domestic profits that Foreign's AD regime forces upon Home's exporters has further consequences. Sacrificing domestic profits might not be worth it: An exporting firm, who earns relatively little on the export market, may get more profits by giving up exporting altogether. Firms will serve only their domestic market if

\[
\pi_D^H(c) > \pi_D^H(c) + \pi_X^H(c) \Leftrightarrow c > c_X^H - \sqrt{1 - \beta^H} \left(c_D^H - c_X^H\right) \quad \text{24}
\]

which defines a new cutoff for exports:

**Result 2:** Antidumping toughens export selection

The export cutoff cost for firms who must avoid antidumping petitions is given by:

\[
c_{XA}^H = c_X^H - \sqrt{1 - \beta^H} \left(c_D^H - c_X^H\right)
\]

(3.13)

To consider exporting to a country that enforces a "credible threat" antidumping policy, a firm must be more productive than were it to export to an unprotected country. The effect goes beyond the necessity to break even on the export market, sacrificing some domestic profits must also be worthwhile.

Home firms with intermediate productivity will give up exporting to the AD regime in Foreign and concentrate on their domestic market. The more important the domestic market is (lower \( \beta^H \)), the more productive a firm needs to be to find exporting worth the sacrifice of domestic profits. Modeling

---

24 From (3.8), to be able to set an export price lower enough to break even abroad, an exporting firm's marginal cost must satisfy \( c \leq c_X^H - (1 - \beta^H) \left(c_D^H - c_X^H\right) \). The present condition is stronger, as \( (1 - \beta^H) < \sqrt{(1 - \beta^H)} \).
heterogeneous firms has thus so far given us two new insights into how firms may react when facing AD: For fear of litigation, the most productive firms will lower their domestic price and raise the export price. Firms with intermediate productivities will no longer find exporting worthwhile.

Some previous models of antidumping, notably Gallaway, Blonigen and Flynn (1999) and Pauwels, Vandenbussche and Weverbergh (2001), have assumed that domestic distortion does not take place, so that firms pass the increased cost of exporting entirely on to the export market. In terms of the present model, this assumption of "no domestic distortion" would correspond to setting $\beta^H = 0$, regardless of the relative importance of markets.

Whether domestic distortion takes place is an interesting unexplored empirical question that I shall not settle here. Suffice to notice that only one result is affected qualitatively by domestic distortion: The (static) efficiency gains in Home when exporters reduce their domestic prices are eliminated; with $\beta^H = 0$, the optimal prices that avoid AD are $p_{XH}^H(c) = \tau^F p_D^H(c)$, Home exporters set their domestic prices optimally (5), and pass the export cost fully through to Foreign's consumers. Foreign's welfare losses from more expensive imports are maximized, and the export selection hits even harder because some firms will only find it profitable to export if they can distort on their domestic markets ($c_{XH}$ is decreasing in $\beta^H$).

### 3.2.6 Short-Run Consequences of the Antidumping Regime

The direct effect of Foreign's AD regime is that Home exporters, depending on their productivity, either reduce their exports or give up exporting altogether. Because the threat of AD is assumed permanent, these effects are also permanent, and in the long run the reduced competition on Foreign's market will encourage new firms to set up there. To understand the consequences of Foreign's AD regime, it is helpful, however, first to trace out how markets adjust before firms are allowed to enter or exit. The short-run version of the model in Melitz and Ottaviano (2008) is the natural framework for such an analysis.

The situation I will examine is that Foreign unexpectedly announces its AD policy (all Home exporters have a sufficiently high risk and cost of being caught that dumping is not worthwhile) and that this policy is immediately credible. Such a scenario is unrealistic, but the main intention is to separate the short-run implications; results will be more clear than in a scenario where firms in Home must gradually learn the severity of Foreign's policy.
If there is no entry and exit, active firms will respond to how the changed behavior of Home exporters outlined above will change the average prices $\bar{p}^H$ and $\bar{p}^F$, and the number of firms operating in each market $N^H$ and $N^F$. Short-run expressions for the cutoffs (denoted $\tilde{c}_D^l$) will continue to summarize the behavior of firms, because the cutoff definitions (3.3) still hold:

$$\tilde{c}_D^l = \frac{1}{\gamma + \eta N^H_A \bar{p}_A^l} \left( \gamma \alpha + \eta N^F_A \bar{p}_A^l \right) \text{ for } l=H, F. \quad (3.14)$$

The number of active firms has fallen in Foreign, $N_A^F$ now excludes the firms in Home that have given up exporting. These missing exporters also raise the average price in Foreign, $\bar{p}_A^F$, as do the higher prices set by the remaining Home exporters. (Showing that the average price indeed increases is rather tedious, the interested reader may find the algebra in Appendix 1). From (3.14), the higher average prices and fewer available varieties will drive the domestic cutoff $\tilde{c}_D^F$ up. In the short run, the domestic firms in Foreign will therefore increase their price, quantity and profits: The AD regime has anti-competitive short-run effects on top of the welfare losses through lower extensive and intensive margins of imports.

In Home, the lower domestic prices set by Home exporters will lead to a decrease in the average price, as shown in Appendix 1. Following (3.14), this reduction in the average price drives the short-run cutoff $\tilde{c}_D^H$ down in Home: Some very unproductive firms that were close to earning zero profits will choose zero production, because of the increased competition, but by assumption they will not exit. Moreover, from (3.4), this increased competition will also push some of Foreign's relatively unproductive out of Home's market. When the cutoff falls, the remaining firms (both domestic and exporting from Foreign) will lower prices, quantities and profits. On net, Home's consumers will benefit, because welfare unambiguously increases with a lower domestic cutoff.

In Foreign, the short-run consequences of the AD regime resemble those of a short-run unilateral trade restriction (an increase in $\tau^F$), but all effects in Home are specific to AD. Although this short-run scenario is admittedly unrealistic, empirical evidence indicate that something qualitatively similar happens in the data: Konings and Vandenbussche (2009) estimate that for firms that receive AD protection will increase their domestic sales with 5% com-
pared to an unprotected control group, but those firms also export will see their export sales diminish by 8%. The authors present some complementary explanations, but the only formal model that replicates their results is the present analysis.

3.2.7 Long Run Consequences of the Antidumping Regime

Because of the reduced competition in Foreign's AD-protected market, the expected profit of setting up a firm there will be positive. When the effects of Foreign's AD regime are permanent, new firms will enter Foreign, and as shown below, changes in entry patterns will eventually more than reverse the short-run predictions from the previous section. In this long run analysis, free entry ensures that the expected profits (export and domestic) of setting up a firm in Foreign are equal to the entry cost $f_E$:

$$\int_0^{c_F} \pi_D^F(c)dG(c) + \int_{c_F}^{\infty} \pi_X^F(c)dG(c) = f_E \quad (3.15)$$

Without any AD, both Foreign and Home's free entry condition look like this equation. In the AD scenario, however, Foreign's domestic profits $\pi_D^F(c)$ are higher due to the lower imports from Home, and it will therefore take more entrants and a lower cutoff $c_D^F$ to drive expected profits of entering down to zero.

Home, on the other hand, is less attractive for an entering firm, because Foreign's AD regime has reduced Home's export potential. Fewer firms will therefore enter in Home. Both the decreased profits and the reduced probability of being productive enough to become an exporter are reflected in the new free entry condition:

$$\int_0^{c_H} \pi_D^H(c)dG(c) + \int_{c_H}^{\infty} \left[\pi_{DA}^H(c) + \pi_X^F(c) - \pi_D^H(c)\right]dG(c) = f_E \quad (3.16)$$

The two free entry conditions give two equation in two unknowns, the domestic cutoffs $c_D^H$ and $c_D^F$, but these can now only be determined numerically. To evaluate the long-run consequences of Foreign's permanent AD regime, I must therefore rely on simulations.

These numerical solutions for (3.15) and (3.16) unambiguously show that $c_D^H$ increases and $c_D^F$ decreases in the antidumping scenario. Foreign's AD regime has reduced the attractiveness of setting up a firm in Home, and Foreign
is therefore a relatively more attractive place to locate. In the long run, the firms that attempt entry in Foreign will more than replace the displaced imports from Home, and competition will increase. In Home, fewer firms will enter, and eventually competition will start to decrease.\(^{25}\)

All long-run implications of Foreign’s AD regime are presented below in Result 3 for Home and Result 4 for Foreign. Appendix 2 contains graphs from the simulations, illustrating the results. As with average prices in the previous section, it is possible, but tedious, to express entrants, varieties, price variance and welfare in terms of these new cutoffs. Derivations and expressions may be found in Appendix 1.

**Result 3:** Long run effects of a trading partner’s antidumping enforcement

<table>
<thead>
<tr>
<th>Table 1a: Firm selection in Home</th>
<th>Table 1b: Consumption in Home</th>
</tr>
</thead>
<tbody>
<tr>
<td>variable</td>
<td>change</td>
</tr>
<tr>
<td>Domestic cutoff, (c^H_D)</td>
<td>+</td>
</tr>
<tr>
<td>Export cutoff, (c^H_{XA})</td>
<td>–</td>
</tr>
<tr>
<td>Productivity ((\bar{c}^H)^{-1})</td>
<td>–</td>
</tr>
<tr>
<td>Entrants, (N^H_E)</td>
<td>–</td>
</tr>
</tbody>
</table>

Table 1a summarizes the long-run effects on the composition of firms in Home. Because of its hampered export potential, fewer firms will enter Home, and competition there will therefore decrease: Firms with higher marginal costs can survive, and the average productivity of operating firms therefore falls. Firms must be more productive to become exporters, the effect of the lower export cutoff in (3.13) is accentuated by tougher competition in Foreign (see below).

Table 1b summarize the effects for consumers in Home, with the \(\Delta U^H\)-column indicating how the change in the variable affects welfare. Lower entry in Home means that consumers there have fewer va-

---

\(^{25}\) In Melitz (2003), all firms eventually die out as they are hit by exogenous "bad shocks", and new firms enter to replace them. This process is not modeled explicitly in Melitz and Ottaviano (2008), but implicitly, all firms have been replaced in the transition from one long-run equilibrium to another. I am thankful to Gianmarco Ottaviano for confirming this.
rieties to choose from. Decreased competition will drive the average price up, in spite of the lower domestic prices set by Home exporters. These lower domestic prices drive the price variance up, however, which enables consumers to substitute towards the varieties that Home exporters sell. On net, however, welfare falls.

It is possible to construct simulations where Home consumers have a small net welfare gain. This may happen if a) Home is very large relative to Foreign, \( L^H \gg L^F \), and b) Home has higher export barriers than Foreign \( \tau^H \gg \tau^F \) and c) varieties are good substitutes for each other (low \( \gamma \)). Then Home will still have relatively many active exporters to the AD regime, and the positive welfare effects through \( \sigma^2_{p,H} \) of lower domestic prices of exported varieties may dominate.

**Result 4:** Long-run effects in a country enforcing antidumping

<table>
<thead>
<tr>
<th>Table 2a: Firm selection in Foreign</th>
<th>Table 2b: Consumption in Foreign</th>
</tr>
</thead>
<tbody>
<tr>
<td>variable</td>
<td>change</td>
</tr>
<tr>
<td>Domestic cutoff, ( c^F_D )</td>
<td>+</td>
</tr>
<tr>
<td>Export cutoff, ( c^F_X )</td>
<td>–</td>
</tr>
<tr>
<td>Productivity ( (\bar{c}^F)^{-1} )</td>
<td>–</td>
</tr>
<tr>
<td>Entrants, ( N^F_E )</td>
<td>–</td>
</tr>
</tbody>
</table>

As summarized in Table 2a, the reduced competition in Foreign due to falling imports attracts new entrants. These new entrants eventually drive competition down below what it was before the AD regime. A firm must have lower marginal costs to survive and average productivity increases. Because of the decreased competition in Home described above, firms in Foreign find exporting easier: The higher export profits raise export sales of existing exporters and enable less productive firms to export.

From Table 2b, we see that consumers benefit in Foreign. The new entrants more than compensate for the varieties that are no longer imported from Home, and the increased competition is enough to offset the higher prices of those varieties that are still imported. The price...
variance, however, decreases because of the fewer and more expensive imports, removing some of the welfare gain. On net, however, consumers benefit.

The negative contribution from reduced price variance may dominate and give a net welfare loss in Foreign, this happens under the same asymmetry conditions that gave Home a welfare gain above: \( L^H >> L^F, \tau^H >> \tau^F \) and low \( \gamma \).

In short, Foreign's AD protection allows it to "steal firms from Home" and thereby enjoy welfare gains on the expense of Home. These welfare gains are always lower than Home's welfare loss, so there is no room for a compensation scheme between the two countries that leaves everyone better off in the AD regime.26

3.3 Discussion

The welfare effects of the AD regime presented in results 3 and 4 are similar to what would happen if Foreign unilaterally restricted trade by increasing \( \tau^F \). As Melitz and Ottaviano (2008) show, a country can in the long run enjoy welfare gains from a unilateral trade restriction by attracting firms, again on the expense of its trading partner. The two trade policies are not identical, however: Under the AD regime, Home's welfare losses are softened by the lower domestic prices of Home exporters; if Foreign increases \( \tau^F \), this softening is absent. The simulations confirm that AD gives a "cheaper" welfare increase: For a given increase in Foreign's welfare (through either AD or increasing \( \tau^F \)), Home suffers a lower welfare loss from AD than from higher \( \tau^F \).

Despite these softer welfare losses from AD, the main message from the analysis of long-run welfare effects is one of concern. Countries have an incentive to unilaterally enforce AD to a degree where it affects firms' location decisions, just as they have an incentive to unilaterally increase their tariffs. The difference is that the WTO allows use of AD.

26 Results 3 and 4 are qualitatively the same across parameter specifications. Changing technology parameters \( f_E, k \) and \( c_M \) or the demand parameters that govern sector size, \( a \) and \( \eta \), has no quantitative effects, either. As the final paragraphs of results 3 and 4 hint, welfare losses in Home and gains in Foreign are magnified with higher \( \gamma \), because consumers then care more about variety access and less about price differences. Moreover, the lower trade costs are, the more Foreign's AD policy distort entry patterns, again magnifying the welfare effects.
The situation is akin to a prisoners' dilemma: Foreign's gains from enforcing AD arise only because the AD-protected country becomes relatively more attractive as a location for firms. If Home were to retaliate by also adopting AD legislation and enforcing it credibly, Foreign's welfare gains would disappear, and both countries would lose in comparison to policy regimes without AD. The AD policy equilibrium is inefficient, just like the policy equilibrium for unilateral increases in $\tau$.

Ossa (2011) shows how the GATT/WTO negotiation rules of reciprocity and nondiscrimination (most favored nations) help countries coordinate and escape the prisoner's dilemma outcome for tariff increases. Since AD is sanctioned by the WTO, there is no institutional support to guide countries out of an outcome where countries enforce AD legislation against each other, to the detriment of all.

From this analysis, the recent spread of AD legislation has bleak perspectives. The limited trade-depressing effects of AD that Egger and Nelson (2010) find on aggregate data suggest, however, that we are not in the prisoner's dilemma outcome: The average country does not seem to use AD so intensively that it has noteworthy effect on firm locations. In fact, the current situation of AD use that we observe may be closer to the asymmetric AD scenario described above. Vandenbussche and Zanardi (2010) show that some new adopters of AD (Brazil, India, Mexico, Taiwan and Turkey) use the legislation enough to generate substantial decreases in their imports.

Finally, it is worth summarizing the theoretical gains from modeling AD with heterogeneous firms. Although this paper is the first to point to how a country may gain in the long run from enforcing AD, that particular result can also be derived in a model with homogenous firms. The strength of the framework employed here lies in the ability to expose how effects differ across firms and how export selection and productivity change.

3.4 Conclusion

This paper has examined the effects of AD in a monopolistic competition model with heterogeneous firms. In the specific policy regime analyzed, AD in one of the two countries is so heavily enforced that firms exporting to the country set prices in a way that avoids any scrutiny by AD authorities. The heterogeneous firms framework provides a series of novel effects of AD:

The direct effects are that exporters in Home (the unprotected country) will either lower their domestic prices to be able to set lower export prices, or
they will stop exporting altogether. In the short run, these lower domestic prices hurt Home's non-exporting firms, too, but consumers in Home gain in the short run from the increased competition. In the long run, however, fewer firms will enter Home because of the reduced export potential, and competition will fall. In the long run, the least productive firms gain from this reduced competition, whereas the productive firms still suffer from the reduced export potential. Consumers in Home lose in the long run, competition is lower and there are fewer varieties.

In Foreign, the AD-protected country, competition falls in the short run, because of the reduction in imports. All local firms have higher domestic sales, but exporters lose some export profits because of the lower prices in Home. In the long run, however, new firms will enter Foreign, eventually increasing competition above what is was without AD protection. Foreign's least productive firms therefore have lower profits, whereas exporters gain from decreased competition in Home. Increased competition and more varieties raise the welfare of Foreign's consumers.

These results show how analyzing AD with heterogeneous firms and allowing for long-run industry reallocations may provide new policy insights, and it also raises concerns that countries may use AD policies to enjoy welfare gains on expense of their trading partners.

Appendix 1: Average prices, number of entrants, varieties and welfare
Notation: \( N_E^H \) and \( N_E^F \) denote the number of firms attempting entry in Home and Foreign, respectively. They relate to the number of varieties available to consumers in the following manner:

\[
N^H = N^H_E G(c_D^H) + N^H_E G(c_X^H) \quad \text{and} \quad N^F = N^F_E G(c_D^F) + N^F_E G(c_X^F)
\]

I shall occasionally also use the shorthands \( \rho^H = (\tau^H)^{-k} \) and \( \rho^F = (\tau^F)^{-k} \)

Average prices, Foreign:
Domestic varieties are still priced as

\[
p^F_D(c) = \frac{1}{2}(c^F_D + c), \quad c \in [0, c^F_D],
\]

and they make up a fraction \( N^F_E G(c^F_D)/N^F \) of the varieties available in Foreign.
Imported varieties are in the AD regime priced as

\[ p_{XA}^F(c) = \frac{1}{2} \left( \beta^H c_D^F + \left( 1 - \beta^H \right) c_X^F + \tau^F c \right), \quad c \in [0, c_{XA}^H]. \]

and they make up the fraction \( N_E^H G(c_{XA}^H) / N_F^F \) of the varieties in Foreign.

The average price can therefore be computed from

\[ \bar{p}_A^F = \frac{N_E^F G(c_D^F)}{N_F^F} \int_0^{c_D^F} p_D^F(c) dG(c) + \frac{N_E^H G(c_{XA}^H)}{N_F^F} \int_0^{c_{XA}^H} p_{XA}^H(c) dG(c) \]

Without AD, average prices in Foreign are \( \bar{p}_A^F = \frac{2k + 1}{2k + 2} c_D^F \), so average prices are higher under AD when

\[ (2k + 1)c_D^F < \tau^F \left( k + 1 \right) \left( \beta^H c_X^F + \left( 1 - \beta^H \right) c_D^F \right) + \tau^F k c_{XA}^H \]

using that \( c_X^H = c_D^F / \tau^F \), inserting for \( c_{XA}^H \) and simplifying reveals that this condition is satisfied whenever \( c_X^H < c_D^H \). As claimed in section 3.2.6, average prices increase in Foreign. In the long run, cutoffs will change enough to counter this result.

**Average prices, Home**

Home non-exporters set prices as

\[ p_D^H(c) = \frac{1}{2} \left( c_D^H + c \right), \quad c \in [0, c_D^H]. \]

Their varieties make up a fraction \( N_E^H \left[ G(c_D^H) - G(c_{XA}^H) \right] / N^H \) of varieties for sale in Home.

Home exporters set prices as

\[ p_D^H(c) = \frac{1}{2} \left( \beta^H c_X^H + \left( 1 - \beta^H \right) c_D^H + c \right), \quad c \in [0, c_{XA}^H], \]

and these varieties make up a fraction of the varieties available in Home.

Foreign exporters set prices as

\[ p_X^F(c) = \frac{1}{2} \left( c_D^H + \tau^H c \right), \quad c \in [0, c_D^H / \tau^H], \]

corresponding to the fraction \( N_E^F \left[ G(c_D^H / \tau^H) \right] / N^H \).

The average price can therefore be computed from:
\[
\bar{p}_A^H = \frac{N_E^F}{N^H} G\left(c_D^H\right) - G\left(c_{X_A}^H\right) \int_{c_{X_A}^H}^{c_D^H} \frac{p_D^H(c)}{G(c_D^H) - G(c_{X_A}^H)} dG(c) + \\
\frac{N_E^H G\left(c_{X_A}^H\right)}{N^H} \int_0^{c_{X_A}^H} \frac{p_{X_A}^H(c)}{G(c_{X_A}^H)} dG(c) + \frac{N_E^F}{N^H} G\left(c_D^F\right) \int_0^{c_D^F/\tau^H} \frac{p_X^F(c)}{G(c_D^F/\tau^H)} dG(c) \Leftrightarrow \\
\bar{p}_A^H = \frac{2k + 1}{2k + 2} c_D^H + \frac{N_E^H}{N^F} \frac{1}{2} \beta^H (c_D^H - c_X^H) G(c_{X_A}^H)
\]

which is lower than the average prices without AD, \(\bar{p}_A^H = \frac{2k + 1}{2k + 2} c_D^H\), as claimed in section 3.2.6. As for Foreign, the result is countered by changed entry in the long run.

**Number of Entrants**

For Foreign, there are two more conditions in the model relating the average price to the number of entrants and varieties, the threshold price condition

\[
N^F c_D^F - N^F \bar{p}_D^F = \frac{\gamma}{\eta} \left(\alpha - c_D^F\right) \quad \text{(from (3))}
\]

and the number of active firms,

\[
N^F = N_E^F G\left(c_D^F\right) + N_E^H G\left(c_{X_A}^H\right)
\]

Combining these with the average prices gives an expression in \(N_E^F\) and \(N_E^H\) only.

\[
N_E^F c_D^F G\left(c_D^F\right) + N_E^H c_D^F G\left(c_{X_A}^H\right) - N_E^F \frac{2k + 1}{2k + 2} c_D^F G\left(c_D^F\right) - \\
N_E^H \left\{ \frac{\tau^F}{\tau^H} \beta^H c_{X_A}^H + \left(1 - \beta^H\right) c_D^H \right\} G\left(c_D^H\right) + \frac{\tau^F}{\tau^H} k + 1 \alpha c_{X_A}^H G\left(c_{X_A}^H\right) = \frac{\gamma}{\eta} \left(\alpha - c_D^F\right) \Leftrightarrow \\
N_E^F + N_E^H \left(\frac{c_{X_A}^H}{c_D^F}\right)^k \left\{ (k + 1) \left[ 1 + \left(1 - \beta^H\right) \left(1 - \frac{\tau^F}{\tau^H} c_D^F\right) \right] - \frac{\tau^F}{\tau^H} k c_{X_A}^H \right\} = 2(k + 1) (c_M)^k \frac{\gamma}{\eta} \left(\alpha - c_D^F\right)
\]

A similar relation can be computed for Home. Inserting average prices into the threshold price condition

\[
N^H c_D^H - N^H \rho^H = \frac{\gamma}{\eta} \left(\alpha - c_D^H\right)
\]

and the number of active firms \(N^H = N_E^H G\left(c_D^H\right) + N_E^H G\left(c_D^H/\tau^H\right)\) gives:

\[
N_E^H G\left(c_D^H\right) c_D^H + N_E^H G\left(c_D^H/\tau^H\right) \rho^H - N_E^H \frac{2k + 1}{2k + 2} c_D^H G\left(c_D^H\right) + \\
N_E^H \left(\beta^H \left(\frac{c_D^H}{c_{X_A}^H}\right) G(c_{X_A}^H) - N_E^H \frac{2k + 1}{2k + 2} c_D^H G\left(c_D^H/\tau^H\right) \right) = \frac{\gamma}{\eta} \left(\alpha - c_D^H\right) \Leftrightarrow \\
N_E^H \left[ 1 + (k + 1) \beta^H \left(1 - \frac{\tau^F}{\tau^H} \frac{1}{c_D^H} \right) \left(\frac{c_{X_A}^H}{c_D^H}\right)^k \right] + \rho^H N_E^H = 2(k + 1) (c_M)^k \frac{\gamma}{\eta} \left(\alpha - c_D^H\right)
\]
Solving for the number of entrants

The number of entrants in Home and Foreign can now be found by solving these two equations for \( N^F_E \) and \( N^H_E \).

Let \( A = \begin{bmatrix} 1 + (k + 1)\beta^H \left( 1 - \frac{c_F^D}{\tau^F \cdot c_D^H} \right) \left( \frac{c_{HA}^H}{c_D^F} \right)^k \end{bmatrix} \) and \( B = \left( \frac{c_{HA}^H}{c_D^F} \right)^k \left\{ (k + 1) \left[ 1 + (1 - \beta^H) \left( 1 - \frac{\tau^F \cdot c_D^H}{c_D^F} \right) \right] - \frac{\tau^F}{c_D^F} \cdot c_{HA}^H \right\} \). Rewrite the two equations as:

\[
N^F_E + N^H_E \cdot B = 2(k + 1) (c_M)^k \cdot \frac{\gamma}{\eta \cdot (c_D^F)^{k+1}} \quad \text{and}
\]

\[
N^H_E A + \rho^H N^F_E = 2(k + 1) (c_M)^k \cdot \frac{\gamma}{\eta \cdot (c_D^F)^{k+1}}
\]

Isolating for \( N^F_E \) in the upper equation, and inserting into the lower gives:

\[
2(k + 1) (c_M)^k \cdot \frac{\gamma}{\eta \cdot (c_D^F)^{k+1}} \cdot \rho^H - N^H_E B \rho^H + N^H_E A = 2(k + 1) (c_M)^k \cdot \frac{\gamma}{\eta \cdot (c_D^F)^{k+1}} \Leftrightarrow
\]

\[
N^H_E = \frac{1}{A - B \rho^H} \cdot \frac{2(k + 1) (c_M)^k \gamma (\alpha - c_D^F)}{\eta (1 - \rho^H \rho^F)} \left[ \frac{(\alpha - c_D^F)}{(c_D^F)^{k+1}} - \rho^H \frac{(\alpha - c_D^F)}{(c_D^F)^{k+1}} \right]
\]

The expression is somewhat similar to the expression for entrants derived in Melitz and Ottaviano (2008). Rewriting gives:

\[
N^H_E = \left[ \frac{1 - \rho^H \rho^F}{A - B \rho^H} \right] \cdot \frac{2(k + 1) (c_M)^k \gamma (\alpha - c_D^F)}{\eta (1 - \rho^H \rho^F)} \left[ \frac{(\alpha - c_D^F)}{(c_D^F)^{k+1}} - \rho^H \frac{(\alpha - c_D^F)}{(c_D^F)^{k+1}} \right]
\]

which is similar to the number of entrants in Melitz and Ottaviano (2008), corrected with \( \left[ \frac{1 - \rho^n \rho^F}{A - B \rho^H} \right] \). Entry distortions not only take place through changes in cutoffs, but also through this term. In all simulations, \( \left[ \frac{1 - \rho^n \rho^F}{A - B \rho^H} \right] < 1 \), entry is reduced in Home.

The number of entrants in Foreign:
Again, there are some similarities to the number of entrants in Melitz and Ottaviano (2008), rewriting to clarify this:

\[ N_H^F + N_H^H B = 2(k+1)(c_M)k \frac{(\alpha-c_D)}{\eta(c_D)^{k+1}}, \] inserting \( N_H^H \):

\[
N_E^F = \frac{B}{A-B \rho^H} \frac{2(k+1)(c_M)\gamma}{(1+ \rho_H \rho_F)} \left( \frac{\alpha-c_D}{c_D} \right) \left( \frac{\alpha-c_D}{c_D} \right) = 2(k+1)(c_M)k \frac{(\alpha-c_D)}{\eta(c_D)^{k+1}} \frac{1}{A-B \rho^H} \left[ A \left( \frac{\alpha-c_D}{c_D} \right) - B \left( \frac{\alpha-c_D}{c_D} \right) \right]
\]

Entry into both Home and Foreign are adjusted downwards by the term \( \frac{1}{A-B \rho^H} < 1 \). Entry into Foreign is then corrected by \( A \) and \( B \), which for all parameters implies an increase, representing how Foreign has become relatively more attractive as a market.

**Varieties**

With the expressions for the entrants at hand, and numerical solutions for the cutoffs, \( N^H \) and \( N^F \) can be found numerically as:

\[ N_H^H = N_E^H G(c_D^H) + N_E^F G(c_D^F / \tau^F), \quad N_F^H = N_E^H G(c_D^H), \quad N_E^F G(c_D^F / \tau^F) \]

**Computing Welfare under Antidumping**

Welfare is given by:

\[
U = 1 + \frac{1}{2} \left( \eta + \frac{\gamma}{N^l} \right)^{-1} (\alpha - \bar{p})^2 + \frac{1}{2 \gamma} \sigma_p^2, \quad l = H, F
\]

The price variance is given by \( \sigma_p^2 = E(p^2) - \bar{p}^2 \), where \( \bar{p}^l \) has been derived for each country above.

The missing term is the second uncentered moment \( E(p^2) \):

**Foreign**

\( E[p_F^F(c)^2] \) is given by:
\[ E[p^H(c)^2] = \frac{N^F G(c_F^H)}{N^F} \int_0^{c_F^H} [p_{F, A}(c)]^2 dG(c \mid c \leq c_F^H) + \frac{N^H G(c_{X, A}^H)}{N^F} \int_0^{c_{X, A}^H} [p_{X, A}(c)]^2 dG(c \mid c \leq c_{X, A}^H) \]

\[ = \frac{N^F G(c_F^H)}{N^F} \int_0^{c_F^H} \frac{1}{4} (c_F^H + c)^2 \frac{k \epsilon - 1}{(c_F^H)^2} dc + \frac{N^H G(c_{X, A}^H)}{N^F} \int_0^{c_{X, A}^H} \frac{(\tau_F)^2}{4} \left[ \beta^H c_{D, F}^H/\tau_F + (1 - \beta^H) c_D^H + c \right]^2 \frac{k \epsilon - 1}{(c_{X, A}^H)^2} dc \]

The integrals give:

\[ \int_0^{c_F^H} \frac{1}{4} (c_F^H + c)^2 \frac{k \epsilon - 1}{(c_F^H)^2} dc = \frac{1}{2} (c_F^H)^2 \frac{(1 + 4k + 2k^2)}{(1 + k)(2 + k)} \]

\[ \int_0^{c_{X, A}^H} \frac{(\tau_F)^2}{4} \left[ \beta^H c_{D, F}^H/\tau_F + (1 - \beta^H) c_D^H + c \right]^2 \frac{k \epsilon - 1}{(c_{X, A}^H)^2} dc = \]

\[ = \frac{(\tau_F)^2}{4} \left( M^2 + \frac{k}{k + 2} (c_{X, A}^H)^2 + 2M \frac{k}{k + 1} c_{X, A}^H \right) \quad \text{where} \quad M = \beta^H c_{D, F}^H/\tau_F + (1 - \beta^H) c_D^H \]

With all components determined, welfare in Foreign can be computed with numerical values for cutoff.

**Home:**

\[ E[p^H(c)^2] \text{ is given by:} \]

\[ E[p^H(c)^2] = \]

\[ \frac{N^H [G(c_F^H) - G(c_{X, A}^H)]}{N^H} \int_0^{c_F^H} [p_{X, A}(c)]^2 dG(c \mid c \leq c_F^H) + \frac{N^H G(c_{X, A}^H)}{N^H} \int_0^{c_{X, A}^H} [p_{X, A}(c)]^2 dG(c \mid c \leq c_{X, A}^H) \]

\[ = \frac{N^H G(c_F^H)}{N^H} \int_0^{c_F^H} [p_{X, A}(c)]^2 \frac{\epsilon^H}{(c_M)^2} dc + \frac{N^H G(c_{X, A}^H)}{N^H} \int_0^{c_{X, A}^H} [p_{X, A}(c)]^2 \frac{\epsilon^H}{(c_M)^2} dc + \frac{N^H G(c_{X, A}^H)}{N^H} \int_0^{c_{X, A}^H} [p_{X, A}(c)]^2 \frac{\epsilon^H}{(c_M)^2} dc + \frac{N^H G(c_{X, A}^H)}{N^H} \int_0^{c_{X, A}^H} [p_{X, A}(c)]^2 \frac{\epsilon^H}{(c_M)^2} dc \]

Inserting and rearranging, \( E[p^H(c)^2] \) can be written as:

\[ = \frac{N^H}{N^H} \left[ \int_0^{c_F^H} \frac{1}{4} (c_F^H + c)^2 \frac{k \epsilon - 1}{(c_M)^2} dc - \int_0^{c_{X, A}^H} \left( (\beta^H)^2 (c_F^H - c_{F, A}^H/\tau_F)^2 + 2\beta^H (c_F^H - c_{F, A}^H/\tau_F) (c_F^H + c) \right) \hat{G}(c_{X, A}^H) dc \right] \]

\[ + \frac{N^H}{N^H} \left[ \int_0^{c_F^H} \frac{1}{4} (c_F^H + c)^2 \frac{k \epsilon - 1}{(c_M)^2} dc \right] \]

The first integral:

\[ \int_0^{c_F^H} \frac{1}{4} (c_F^H + c)^2 \frac{k \epsilon - 1}{(c_M)^2} dc = \frac{1}{2} (c_F^H)^2 \frac{(1 + 4k + 2k^2)}{(1 + k)(2 + k)} \frac{(c_F^H)^k}{(c_M)^k} = \frac{1}{2} (c_F^H)^2 \frac{(1 + 4k + 2k^2)}{(1 + k)(2 + k)} G(c_F^H) \]
The second integral:

\[ -\int_0^{c_{X,A}^H} \left( \left( \beta^H \right)^2 \left( c_D^H - c_F^D / \tau^F \right)^2 - 2\beta^H (c_D^H - c_F^D / \tau^F) \left( c_D^H + c \right) \right) \frac{k c^{k-1}}{(c_M)^k} dc \]

\[ = \frac{1}{4} G(c_{X,A}^H) \left( \beta^H \right) (c_D^H - c_F^D / \tau^F) \left( \left( \beta^H \right) (c_D^H - c_F^D / \tau^F) - 2c_D^H - 2c_{X,A}^H \frac{k}{1 + k} \right) \]

(The expression could be reduced a bit further, but since I insert the results in a simulation program, the exact expression matters little).

The third integral:

\[ \int_0^{c_X^F} \frac{\tau^H}{4} \left( c_X^F + c \right)^2 \frac{k c^{k-1}}{(c_X^F)^k} dc = \frac{1}{2} \left( c_D^H \right)^2 \frac{1 + 4k + k^2}{(1 + k)(2 + k)} \]

Weighting and summing the three integrals, the first and the third simplify each other:

\[ E[p^H (c)^2] = \frac{1}{2} \left( c_D^H \right)^2 \frac{1 + 4k + k^2}{(1 + k)(2 + k)} + \frac{1}{4} \frac{N_E^H}{N_H^H} G(c_{X,A}^H) V \left( V - 2c_D^H - 2c_{X,A}^H \frac{k}{1 + k} \right) \]

Welfare for Home can now be computed numerically as well, by inserting all the components in the expression for welfare, above.

**Appendix B: Graphical examples of simulation results**

On the graphs, the solid line represents the variable in question before Foreign imposes the AD policy, the dashed line represents the AD policy. The graphs illustrate some of the long run effects presented in results 3 and 4: Market competition in Home decreases, as captured by increase in the domestic cutoff (Figure 1). Home's export cutoff is reduced quite substantially (figure 2), along with the fall in the number of firms attempting entry (figure 3).

In Foreign, the domestic competition increases (figure 4) as more firms attempt entry (figure 5). A comparison of the overall welfare effects and their magnitudes for the employed parameter values is given by figure 6.

The simulation code is available from the author upon request. Unless otherwise stated, parameter values are: \( \alpha = 5, \gamma = 2, \eta = 8, k = 2, c_M = 5 \) and \( f_E = 1 \). \( L_F^F \) is fixed at \( L_F^F = 10 \) and \( L_H^H \) is the running variable.
Figure 1: The shift in Home's domestic cutoff, as a function of relative country size

Figure 2: The shift in Home's export cutoff

Figure 3: The shift in the number of Entrants, Home

Figure 4: Foreign's domestic cutoff

Figure 5: The shift in the number of Entrants, Foreign

Figure 6: Welfare and relative country size, Home and Foreign
References


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