UC San Diego
UC San Diego Electronic Theses and Dissertations

Title
Three essays on international trade

Permalink
https://escholarship.org/uc/item/10z3k0rr

Author
Molina, Danielken

Publication Date
2012

Peer reviewed|Thesis/dissertation

eScholarship.org Powered by the California Digital Library
University of California

UNIVERSITY OF CALIFORNIA, SAN DIEGO

Three Essays on International Trade

A dissertation submitted in partial satisfaction of the
requirements for the degree
Doctor of Philosophy

in

Economics

by

Danielken Molina

Committee in charge:

Professor James Rauch, Chair
Assistant Professor Thomas Baranga
Professor Lawrence Broz
Professor Gordon Hanson
Associate Professor Marc Muendler

2012

Copyright
Danielken Molina, 2012
All rights reserved.

The dissertation of Danielken Molina is approved, and it is acceptable in quality and form for publication on microfilm and electronically:

____

____

____

____

____

Chair

University of California, San Diego

2012

DEDICATION

To my parents and siblings, thank you so much, I could have not started this journey without your continuous love, patience and support. Dad, thank you for teaching me the love for knowledge. Mom, thank you for teaching me the love for life. Evelyn, thank you for loving me as my own mom. Jairo, thank you being my second dad. Sara my love, my joy, my life, without you I would have quitted this project a long time ago, thank you for giving me one million reasons to finish this project. To the rest of my family, thank you all for your support.

TABLE OF CONTENTS

Signature Page . . . iii

Dedication . . . iv

Table of Contents . . . v

List of Figures . . . vii

List of Tables . . . viii

Acknowledgements . . . ix

Vita . . . x

Abstract of the Dissertation . . . xi

Chapter 1 Preparing to Export . . . 1
- 1.1 Introduction . . . 3
- 1.2 Data . . . 8
- 1.3 Exporter Types and Workforce Characteristics . . . 11
- 1.4 Preparing to Export . . . 17
- 1.5 Predictors of Exporter Performance . . . 26
- 1.6 Concluding Remarks . . . 28
- 1.7 Bibliography . . . 30

Chapter 2 Financing Constraints . . . 49
- 2.1 Introduction . . . 51
- 2.2 External Financing and Related Literature . . . 56
  - 2.2.1 Relevance of External Financing . . . 56
  - 2.2.2 Theoretical Related Framework . . . 58
- 2.3 Data . . . 59
- 2.4 Empirical Strategy and Results . . . 61
  - 2.4.1 Empirical Strategy . . . 61
  - 2.4.2 Results . . . 64
- 2.5 Conclusions . . . 67
- 2.6 Bibliography . . . 69

Chapter 3 Air Transport Costs . . . 81
- 3.1 Introduction . . . 83
- 3.2 The Model . . . 85
  - 3.2.1 Set-up . . . 85
  - 3.2.2 Demand . . . 87

3.2.3 Production 88
3.2.4 Air Cargo Carriers 92
3.2.5 Equilibrium 97
3.2.6 Comparative Statics 99
3.3 Empirics 105
3.3.1 Results 108
3.4 Conclusions 110
3.5 Bibliography 111

LIST OF FIGURES

Figure 1.1: Density Estimates of Size and White-Collar Shares 33

Figure 2.1: GDP and Total Export Growth 1996 – 2006 71
Figure 2.2: Lending Rate, Credit to Private Sector and Real Exchange Rate 71

Figure 3.1: GDP per Capita (ln) vs. Number of Air Carriers, year 2009 . . 113
Figure 3.2: Optimal Number of Air Cargo Carriers. 113

LIST OF TABLES

Table 1.1: Export Status Ordering 34
Table 1.2: Exporter Premia Conditional on Log Firm Size 35
Table 1.3: Logit Prediction of Future Export-Market Participation 36
Table 1.4: Foreign Demand and Future Export-Market Participation 37
Table 1.5: Hires from Exporters 38
Table 1.6: Hires from Exporters with Region and Size Interactions 39
Table 1.7: Hires from Exporters and Anticipated Export Status 40
Table 1.8: Separations of Recent Exporter Hires 40
Table 1.9: Predictions of Future Exporter Performance 41
Table 1.10: Predictions of Exporter Performance for Departing Workers . . . 42
Table 1.1: Firm Characteristics by Industry 44
Table 1.1: Summary Statistics 45
Table 1.1: Education Categories 46
Table 1.2: Occupation Categories 47

Table 2.1: Summary Statistics 72
Table 2.2: Export Margins and External Financing 72
Table 2.3: Export Margins and Sources of External Financing 73
Table 2.4: Export Margins, Term Structure and Currency Composition . . 74
Table 2.5: Export Margins, External Financing per Industry 75
Table 2.6: Export Margins in the Crisis Period 76
Table 2.7: Export Margins and the Balance Sheet Effect 77

Table 3.1: Comparative Statics on Carriers and Manufacturers 115
Table 3.2: Comparative Statics on the Extensive and Intensive Margin . . . 116
Table 3.3: Countries in the Sample 117
Table 3.4: Summary Statistics 117
Table 3.5: Air Shipping Prices and Competition 118
Table 3.6: Air Shipping Prices by Cargo Load 119

ACKNOWLEDGEMENTS

I would like to thank all of my committee members for their continuous support and infinite patience. I would like to acknowledge Professor James Rauch for his support as a chair of my committee. I would like to thank Professor Gordon Hanson for his guidance, patience and comments. I would also like to thank Professor Marc Muendler for letting me work with him. His comments and thorough revisions in all of these three chapters have been invaluable.

Chapter 1 was written jointly with Professor Marc Muendler.

VITA

Vita2001	B. S. in Economics, Universidad del Rosario, Bogotá, Colombia.
Vita2005	M. S. in Economics, Universidad del Rosario, Bogotá, Colombia.
Vita2012	Ph. D. in Economics, University of California, San Diego.

ABSTRACT OF THE DISSERTATION

Three Essays on International Trade

by

Danielken Molina

Doctor of Philosophy in Economics

University of California, San Diego, 2012

Professor James Rauch, Chair

This dissertation is composed by three chapters. In Chapter 1 I use detailed information on labor composition of Brazilian firms to show that even though exporting firms are similar in the workforce composition, it is non-observable worker characteristics that matter the most to determine wether an exporting firm will become a future successful exporter. I find that the prior working experience of workers is a key component in determining a firm's future export success. Results show that hiring away workers with previous experience in other exporting companies has a significant effect on a firm's future probability of becoming a successful exporter. Furthermore, hiring these key workers increases a firm's market penetration and a firm's number of exporting destinations.

In Chapter 2 I use detailed firm level data on a firm's external sources of financing and I show that firms with higher debt balances export less and grow at lower rates, especially during periods of economic distress. I use this data to provide evidence that financing constraints affect firms' extensive and intensive margins of exports. However, only a subset of financing constraints are related to exports. I show that short-term debt with domestic banking institutions is negatively related to a firm's extensive and intensive margins of trade, while supplier trade debt has a positive effect on a firm's intensive margin of exports. I show that firms located in sectors with higher dependence on external financing exhibit higher growth in their intensive margins of exports.

In Chapter 3 I focus my attention a transport costs. In this chapter, I focus my attention on air cargo shipping and I extend the Melitz (2003) firm heternogenous model of trade by including a cargo shipping sector characterized by a oligopolistic competition structure with fixed entry costs. The market competition in air cargo shipping enables me to derive endogenous pricing rules that vary with the number of cargo carriers per route. Empirical results with US cargo data confirm the importance of competition in air cargo shipping prices.

Chapter 1

Preparing to Export

Abstract

We document considerable heterogeneity among Brazilian exporters in export market participation over time and in employment. But this marked diversity among exporters is not reflected in their workforce composition regarding observed worker skills or occupations. Using linked employer-employee data, we turn to a typically unknown worker characteristic: a worker's prior experience at other exporters. We show that expected export status, predicted with destination-country trade instruments, leads firms to prepare their workforce by hiring workers from other exporters. Hiring former exporter workers predicts both a wider reach of destinations and a deeper penetration of destinations. The evidence is consistent with the hypothesis that exporters actively prepare for expected export-market access and with the idea that few key workers can affect a firm's competitive advantage.

Keywords: International trade; exporter behavior; trade and labor market interactions.

JEL Classification: F12, F14, F16.

1.1 Introduction

A large body of empirical evidence and trade theories suggests that exporters substantively differ from non-exporters regarding their size, productivity and workforce composition.[1] To learn more about successful exporters and continuous export-market participation, this paper compares Brazilian exporters among themselves regarding the time pattern of exporting and their workforce characteristics. We document that firms actively prepare for expected exporting by hiring a few key workers away from other exporters, and we provide evidence that hiring former-exporter workers is a strong predictor of various aspects of export-market success.

There is considerable heterogeneity in performance and sizes among exporters. When we rank Brazilian exporters by their export-market participation over three consecutive years, this performance ranking is mirrored in an almost perfectly monotonic size ranking from only about 80 workers at in-out switching exporters to 550 workers at exporters with a sustained OECD-market presence. Surprisingly, the substantive heterogeneity in export performance and sizes is not reflected in observable workforce characteristics. The workforce composition regarding skills and occupations is economically similar among otherwise diverse exporters and in some cases statistically indistinguishable. This leads us to hypothesize that typically unobserved worker characteristics are important determinants of export-market performance.

We use rich linked employer-employee data for the universe of formal Brazilian manufacturing firms and their export behavior between 1990-2001 to extract an otherwise unobserved worker characteristic: a worker's prior experience at other exporting firms. We define *hires from exporters* as the head count of hired workers whose immediately preceding formal employment was at an exporter. We hypothesize that expected favorable export conditions in the future, predicted by current demand conditions abroad, lead firms to prepare workforces. To provide evidence

[1]The literature documents exporter premia for many countries, beginning with Bernard and Jensen (1995) for U.S. manufacturing exporters. Differences typically exist even before export-market entry. Isgut (2001) presents evidence for Colombia and Alvarez and López (2005) for Chile, consistent with firm or plant-level advantages prior to exporting.

on the hypothesis, we propose and implement a new identification strategy for export preparations in economically stable times: we use current sector-level imports to destinations outside Latin America from source countries other than Brazil as instruments to predict a Brazilian firm's export status next year.[2] The so instrumented future export status in turn predicts significantly more worker hires from other exporters in the current year.

Firms in Brazilian regions with many exporters, large firms, and firms that expect lasting export-market participation react most responsively in hiring away other exporters' workers. A corollary of our hypothesis is that firms for whom foreign-demand conditions predicted a high probability of export-market participation, but who are subsequently not observed to become exporters, should let go again the recently poached hires from exporters.[3] Our data show indeed that unexpectedly unsuccessful exporters separate again from most of their recently hired former exporter workers.

Former-exporter hires predict both a wider reach of destinations and a deeper export-market penetration. These effects are strongest when there is a large overlap of export destinations between the former and the current employer. Hiring workers from marketing-related occupations at former exporters predicts a wider reach of destinations, whereas hiring skilled production workers from exporters predicts a deeper penetration of destinations.

Our findings are consistent with the idea that exporters actively build up workforce expertise for expected export-market access. Results also suggest that worker mobility may be a crucial mechanism by which knowledge spreads through an economy; we find that firms losing workers to other exporters do not suffer a significant decline in the number of export destinations, only a decline in market penetration, whereas hiring firms experience improvement in both dimensions.

Recent trade models investigate industry dynamics when firms simultaneously engage in innovation and export-market participation, where one activity

[2]Our panel data allow us to simultaneously condition on a rich set of worker and firm characteristics, including a firm's overall employment change, as well as firm, sector and year effects, domestic sector-level absorption and, in some specifications, sector-year trends.

[3]We thank Don Davis for this suggestion.

raises the returns to the other. Yeaple (2005) shows in a static model with ex ante identical firms and heterogeneous workers, whose skill is complementary to innovative technology, that the firms' binary choice of process innovation induces the sorting of more skilled workers to innovative firms, leading to firm heterogeneity ex post and to exporter premia in equilibrium. The Yeaple (2005) model is closely related to our empirical exercise. As multilateral trade costs drop, more firms in the differentiated-goods sector adopt innovative technology and raise their employment, hiring away the top-skilled workers from differentiated-goods producers with lower technology.[4] Departing from ex ante heterogeneous firms, Costantini and Melitz (2008) reintroduce a stochastic productivity component from Hopenhayn (1992) into the Melitz (2003) model and allow firms to choose process innovation. In simulations of the dynamic industry equilibrium, an anticipated future reduction of multilateral trade costs leads firms to adopt innovation in advance, while waiting for export-market participation.[5]

These theory models predict that exporters, and especially larger exporters in Costantini and Melitz (2008), adopt more advanced technology in response to anticipated returns from export-market entry. In our linked employer-employee data for Brazilian exporters, however, we find only minor differences among exporters in workforce skills and occupations, which would expectedly correspond to firm-level technology. There are at least three possible explanations for the puzzlingly small workforce differences: export-market success is mere luck; export-market success is independent of workforce characteristics if process innovations or product-quality upgrades can be achieved regardless of workforce skill; or typically unobserved workforce characteristics are most important for export-market success. Using the workers' prior job history and their experience at other exporters as a proxy to unobserved skill, we document that the latter explanation is most plausible.

[4] Also considering ex ante identical firms, Ederington and McCalman (2008) allow for a continuous technology choice in a dynamic industry-equilibrium model and show that a drop in foreign trade costs raises the rate of technology adoption at exporters while adoption is delayed at non-exporters; but worker skills do not play a role in their model.

[5] Atkeson and Burstein (2008) address price setting by exporters and also analyze the joint innovation and export-participation choice in a dynamic model of trade with heterogeneous firms, allowing for a continuous technology choice.

Much empirical research has established evidence that firms with a competitive advantage self-select into exporting. Research by Clerides, Lach, and Tybout (1998) on plants in Colombia, Mexico and Morocco or by Bernard and Bradford Jensen (1999) on U.S. firms, for instance, shows a significant difference in productivity between exporters and non-exporters but no significant difference in productivity change after export-market entry.[6] Our data allow us to analyze the extent to which firm differences prior to exporting are the outcomes of active firm choices in preparation for exporting.

Much empirical evidence suggests that firms jointly choose innovative activity and export-market participation. Bustos (2011) shows with Argentinean firm data that, once Mercosur reduces import duties in Argentina's neighboring export markets, exporters innovate processes and products significantly more rapidly than non-exporters. Trefler (2004) demonstrates that Canadian plants that face deeper tariff cuts in their product markets under the Canada-U.S. Free Trade Agreement raise plant-level labor productivity faster.[7] Verhoogen (2008) documents that Mexico's exchange-rate devaluation during the 1994 Peso crisis leads initially more productive plants to increase exports and to pursue process certification more frequently than initially less productive plants, consistent with process innovation prior to exporting. Those studies rely on large-scale reforms or macroeconomic shocks for identification, whereas our instrumentation method equally applies to ongoing exporter behavior during tranquil times. Our instrumental-variable method for the universe of a country's firms provides complementary evi-

[6] Most evidence suggests that a firm-level competitive advantage leads to exporting, and typically not the reverse. Exceptions are Van Biesebroeck (2005), who reports evidence that exporting subsequently raises productivity for sub-Saharan African manufacturing firms, and Crespi, Criscuolo, and Haskel (2008) who show in survey data for U.K. firms that exporters who report to have mostly learnt from clients exhibit faster productivity growth.

[7] López (2009) documents in a Chilean plant sample that productivity and investment increase prior to export-market entry and in response to increases in foreign income before entry but not afterwards. Iacovone and Javorcik (2012) use additional information on plant-level capital investment and on the unit price of products for Mexican plants and show that the unit price exhibits an increase two years prior to exporting, suggestive of quality upgrading, and that the increase in unit price coincides with a capital-investment spurt. Those studies rely on a notion of Granger (1969) causality for identification, by which subsequent realizations of firm-level variables should not cause current realizations. Our paper, in contrast, uses sector-level foreign demand shocks for identification, which affect realizations of firm-level variables arguably only through the firms' export status.

dence to structural estimation such as in Aw, Roberts, and Xu (2011), who estimate a model of innovation and exporting choices for Taiwanese electronics plants; they show that allowing for both endogenous exporting and innovation contributes to larger estimated productivity gains. In follow-up research on the Mexican Peso crisis, Frías, Kaplan, and Verhoogen (2009) argue that observed increases in wage premia at exporters after the Peso devaluation are largely shared rents and not associated with upgrading of observed or unobserved workforce skills. In contrast, evidence on exporter behavior during stable times in our paper suggests that firms that expect to be exporters engage in targeted hirings of specific skills.

A related literature on spillovers from foreign-owned to domestic firms considers the moves of individual workers between employers, including case studies (Rhee (1990)) and survey evidence (Gershenberg (1987),Görg and Strobl (2005)).[8] Beyond small-sample evidence, Poole (2012) uses linked employer-employee data from the same Brazilian source as we do and documents a statistically significant increase in earnings of incumbent workers at domestic firms after workers from foreign-owned firms join, but the pay increase is small in economic terms. For export-market participation, in contrast, we find the hiring of a few former exporter workers to be an economically important variable, predicting a probability increase in export-market participation of about 3 percentage points. This is a considerable probability shift, given an overall exporting frequency of only 5 percent in the manufacturing universe, and is similar in magnitude to what only substantive changes in observed workforce characteristics would predict.

The remainder of the paper proceeds as follows. We describe our data in Section 1.2 and document substantial differences among exporters in size, export performance and especially workforce characteristics in Section 1.3. In Section 1.4, we turn to our main analysis of workforce choices in preparation for favorable foreign demand, present the identification strategy, and empirically document active workforce preparations for subsequent exporting. Section 1.5 explores worker and

[8] Alvarez and López (2008) document for Chilean plants that the presence of exporters predicts higher productivity at local suppliers, irrespective of foreign ownership, and, within the same industry, that foreign-owned exporters predict higher productivity of competitors. But worker moves are unobserved in their data.

job characteristics that are closely associated with subsequent exporter behavior. Section 1.6 concludes.

1.2 Data

One data source is the universe of Brazilian exporters: a three-dimensional panel data set by firm, destination country and year between 1990 and 2001. We combine the exporter data with the universe of formal-sector firms and all their formally employed workers. This second data source is a three-dimensional linked employer-employee panel data set by firm, worker and year between 1990 and 2001. The combined employer-employee data provide us with workforce information for exporters in the formal sector, and complement the exporter data with the universe of formal-sector non-exporters. We restrict ourselves to manufacturing firms. We combine these data with worldwide trade flow data by sector to construct instrumental variables (IVs) for a Brazilian firm's export status.

Employer-employee data. Our source for linked employer-employee data is RAIS (*Relação Anual de Informações Sociais*), a comprehensive administrative register of workers formally employed in any sector of Brazil's economy. This register contains the universe of formal Brazilian firms, including non-exporters. RAIS offers information on worker characteristics such as education, a detailed occupational classification of the job, the firm's industry, and the legal form of the company including its foreign ownership, as well as the worker's earnings. We keep observations for the years 1990 through 2001, drop all firms outside manufacturing, and then construct workforce and firm characteristics from employment on December 31st and by tracing recent hires back to their last preceding employer's export status. See Appendix 1.6 for more detail on RAIS. RAIS 1990-2001 records a universe of 49 million formal workers employed at 449,390 manufacturing firms (1,767,491 firm-year observations).

Combined with the SECEX exporter data 1990-2001, we find that 23,518 manufacturing firms are exporters in at least one sample year (87,050 exporter-year observations). So only around 5 percent of formal manufacturing firms are exporters, similar to the around 5 percent exporter share in the U.S. universe of manufacturing firms (Bernard, Jensen, and Schott (2009)). Single-employee firms enter the RAIS records, explaining the apparently low share of exporter firms in the total, compared to data for most other developing countries that censor their samples at a minimum employment level. In terms of employment, manufacturing exporters account for 24 million jobs or roughly half of Brazilian formal employment during the sample period.

Tracing workers to prior and future employers. We track a firm's hires back to their prior employer. We define a relevant hire at a manufacturing firm as a worker accession that is not classified as a transfer between the firm's plants and that lasts at least until December 31st of the calendar year. We then trace the worker back to the last preceding formal-sector employment for up to three prior years and obtain the former employer's export status.[9] This allows us to identify *hires from exporters* as acceding workers whose immediately preceding formal-sector employment during up to three past years was at an exporter. For predictions of exporter performance, we obtain in addition the share of common export destination markets (overlap) between the prior and the current employer, and indicator if the former employer was a continuous exporter for three years, an occupational indicator if the worker's prior employment was in sales (CBO 3-digit classification codes 400 to 499), and another occupational indicator if the worker's prior employment was in an ISCO-88 skilled blue-collar occupation.[10]

We also track workers into the future. First, we follow recent hires from exporters into the next calendar year and identify subsequent separations. We define *separations of recent exporter hires* as hires from exporters whose new employment terminates before December 31st of the following year. Second, we track any worker who separates from a firm to the immediately following formal-sector

[9]For hires from exporters in 1990 or 1991 we use the exporter category in 1992 (see Table 1.1).

[10]We also constructed a common-sector indicator if the prior and the current employer are in the same subsector IBGE industry, an indicator if the worker is employed in the same occupation at the current employer as at the prior employer, and the worker's tenure at the prior employer. We found none of those variables to be statistically significant predictors of exporter performance (Table 1.9), conditional on the aforementioned covariates, and omit them.

employment for up to three subsequent years and obtain the future employer's export status (mirroring the definition for hires from exporters). This allows us to define *departures to exporters* as separating workers whose immediately following formal-sector employment during up to three future years will be at an exporter.

Exporter data. Exporter data derive from the universe of Brazilian customs declarations for merchandise exports by any firm collected at SECEX (*Secretaria de Comércio Exterior*). For comparability to other studies, we remove agricultural and mining firms as well as commercial intermediaries from the exporter data and only keep manufacturing firms that report their direct export shipments. We deflate export sales to their August-1994 equivalents using the monthly U.S. consumer price index (from Global Financial Data). The choice of August 1994 is motivated by the timing of Brazil's last major currency reform in July 1994, which put the Brazilian Real (BRL) value at an initial exchange rate of one with the U.S. dollar (USD). See Appendix 1.6 for more detail on the SECEX data.

Including both non-exporters and exporters, there is a total of 1,767,491 firm-year observations in our manufacturing data (after restricting the sample period to the years 1992-2001 in order to measure export status with two lags). In regression analysis, we will use one lead year so that our basic regression sample will have 1,557,474 firm-year observations for 1992-2000. When we include employment change at the firm level as a covariate in regressions, only firms with observations for two consecutive years remain in the sample, and sample size drops to 1,277,201 firm-year observations for 1992-2000. Given the still large sample size, we will report statistical significance only at the 1-percent significance level throughout this paper.

Worldwide trade flows by sector. Our IVs for expected export status are imports into destinations outside Latin America from source countries other than Brazil, by subsector IBGE. We use WTF data on bilateral trade (Feenstra, Lipsey, Deng, Ma, and Mo (2005)) from 1991 to 2000 to construct the IVs by subsector IBGE, year and six world destinations. The six world destinations are Asia-Pacific Developing countries (APD), Central and Eastern European countries (CEE), North American countries (NAM excluding Mexico), Other Developing countries (ODV), Other Industrialized countries (OIN), and Western European countries (WEU). We remove Latin American and Caribbean countries (LAC) from our set of IVs. We concord the SITC (Rev. 2) sectors at the four-digit level in WTF to subsector IBGE.[11] We then calculate aggregate imports into each foreign destination region, excepting imports from Brazil, by subsector IBGE. The IVs will prove to be significant predictors of export status in Brazil. Conditional on domestic absorption by sector, as well as firm, sector and year effects and detailed firm characteristics, these foreign trade flows are plausibly unrelated to firm- or worker-level outcomes in Brazil other than through export-market shocks.

1.3 Exporter Types and Workforce Characteristics

Exporter categories. To document export success over time, we adopt a lexicographic ranking of export-market participation. We consider the current year and two preceding years and record in which of the three years a firm was an exporter with at least one reported shipment (8 possible combinations). We first order firms by current-year export status (t), within current-year status by past-year status ($t-1$), and within those by two-years past status ($t-2$). Beyond this basic time-pattern ranking, we separate non-exporting firms into those that are permanent non-exporters (non-exporters in every sample year) and current non-exporters (with foreign sales in at least one sample year). We also separate continuous-exporting firms into non-sustained exporters that do not serve one common destination in all three years, into sustained non-OECD exporters that serve at least one non-OECD country for three years, and into sustained OECD exporters that serve at least one OECD country for three years (resulting in a total of 11 possible combinations). Table 1.1 shows our resulting ranking of export success, with the category in the upper-most row showing the least successful exporters (permanent non-exporters) and the lower-most row containing the most successful

[11] Our concordance is available at URL *econ.ucsd.edu/muendler/brazil*.

exporters (sustained OECD exporters).[12]

We choose these export-status categories to clarify beyond a two-period categorization that there is considerable heterogeneity among exporters, both in terms of workforce sizes and export values. As displayed in Table 1.1, our time-pattern and destination-market ranking of export-market success is a refinement of a simpler two-period grouping of exporters into *non-exporters* for three consecutive years, exporters that *quit exporting* (including past quitters), firms that *start exporting* (including past starters), and exporters with *continuous exporting*.[13] Curiously, our refined export-status ranking is almost perfectly mirrored in the firms' ranking by workforce size (column 2). For example, permanent non-exporters have an average size of twelve workers, in-out switchers who recently quit exporting employ 76 workers, recent export starters employ 104 workers, while sustained OECD exporters employ 552 workers on average. This surprising workforce-size monotonicity is preserved for all but one pair of neighboring rows.[14] Our refined export-status ranking is also positively related to export sales (column 3, correlation coefficient of .11 at the firm level).

The vast majority of formal-sector manufacturing firms (over 90 percent) never exports in any year between 1990 and 2001. The 57,149 firms that quit or start exporting make up more than half of all firms that export in at least one year between 1990 and 2001 but account for only 6 percent of all export sales. Even among the continuous exporters, it is the select group of sustained OECD exporters that dominates. The 25,238 sustained OECD exporters are fewer than one-third of all current exporters, but they ship close to 90 percent of Brazilian exports and employ more than half of all exporters workers (and one-third

[12]In an alternative ordering, Alvarez and López (2008) classify firms as permanent exporters if they export in all sample years, as sporadic exporters if they export in at least one sample year, and as non-exporters if they do not export during the sample period. Except for permanent non-exporting, our lexicographic ordering does not depend on the number of sample periods.

[13]About 39 percent of manufacturing exporters are starters; they account for employment of four million workers out of a total of 49 million in manufacturing and command 6 percent of export sales.

[14] A two-period classification would have lumped past quitters with non-exporters, but their workforce size turns out to be more similar to other quit-exporting firms under the refinement. Similarly, a two-period classification would have lumped past starters with continuous-exporting firms, but their workforce is more similar to other start-exporting firms under the refinement.

of all Brazilian manufacturing workers). Table 1.1 in the Appendix reports detailed additional summary statistics. Those statistics corroborate that few leading exporters that continue exporting for years account for most export sales and Brazilian employment. We now turn to the workforce characteristics associated with this heterogeneity among exporters.

Workforce composition. Surprisingly, workforce characteristics do not reflect exporters' performance and size differences (see Table 1.1 in the Appendix). The most prevalent occupation in manufacturing, skilled blue-collar work, is performed by 63 percent of workers at the average manufacturing firm and by around 57 percent of workers at exporters, almost independent of the exporters' export status. The most prevalent schooling level in manufacturing is primary education. There are more primary schooled workers at the average manufacturing firm with a share of 76 percent than at exporters with a share of 67 percent, but there is only minor variation among exporters.

Firm heterogeneity is often described with log premia regressions. Much research has shown with such regressions that non-exporters significantly differ from exporters along several dimensions, including workforce characteristics.Less attention has been paid to differences among exporters. In our exporter-premia regressions, we condition on sector and year effects, as well as on the firm's log employment to control for the part of the exporter premium that is predictable with size differences.

Table 1.2 shows that workers at continuous exporters earn a wage premium of 55 percent (.44 log units) over workers at non-exporters, and even workers at recent export-market quitters earn 38 percent (.32 log units) more than workers at firms with no exports for three years. Only a small part of this wage premium is due to different workforce compositions, as the log wage residual (from a regression on educational and occupational workforce variables) shows. The residual log wage still exhibits a premium between 28 and 42 percent (.25 and .35 log units) over non-exporters. This is consistent with the hypothesis that mostly unobserved worker characteristics are associated with a firm's export status.

Workforce composition differences in Table 1.2 are economically small and not generally statistically significant (at the 1-percent significance level in the universe of firms). Skilled blue-collar occupations, for instance, are the dominant jobs in manufacturing (Table 1.1) and are roughly constant at a 7 to 8 percent premium for exporters of any status over non-exporters. For primary educated workers, the most frequent schooling level in manufacturing workforces, there are differences also among exporters of different status (whereas the raw mean differences in Table 1.1 show no marked variation among exporters of different status). The differences in educational attainment are economically small, however.

One typically unobserved worker characteristic is the worker's prior work experience at an exporter. Continuous exporters hire 43 percent (.36 log units) more workers from other exporters than export starters. Especially when compared to the substantive differences in typically unobserved gross hires from other exporters, observed workforce composition differences in Table 1.2 appear small.[15]

In Figure 1.1, we look beyond mean comparisons and plot nonparametric estimates of densities for firm characteristics. In the left graph of the Figure, the kernel estimates for log employment reflect the marked size rankings from Table 1.1 before, with continuous exporters' sizes exhibiting a clearly right-shifted probability mass over firms that start exporting, firms that quit exporting, and non-exporters in this order. The ranking becomes less clear-cut for shares of white-collar occupations in the right graph of Figure 1.1. While there is still a pronounced difference between non-exporters and exporters, the density functions for exporters with different status exhibit multiple crossings and do not suggest as clear a ranking as there appears to be for sizes. The minor economic differences of workforce characteristics among exporters in Table 1.1 and the right graph of Figure 1.1 suggest that more successful and larger exporters employ scaled-up workforces with similar compositions as their less successful and smaller competitors.

Predictions of future export-market participation. This evidence leads us to hypothesize that former exporter workers possess unobserved skills that are

[15]The differences in pay and gross hires of former exporter workers are even more pronounced in premia regressions that do not condition on size, and workforce characteristics premia are economically more similar among exporters (see online Appendix).

associated with exporter performance and could be more relevant performance predictors than conventional observable workforce differences. Before we investigate this hypothesis in detail in the following Section, we turn to a descriptive regression of future export status on current firm-level characteristics to assess the predictive power of workforce characteristics for export status.

Table 1.3 reports binomial logit predictions for future export-market participation ($t+1$), given today's export participation and firm-level characteristics.[16] All specifications condition on sector and year effects as well as sector-level absorption (to control for sector-level business cycles).[17] Consistent with much prior evidence, firms with larger employment are more likely to be exporters than non-exporters one year later, and firms with more highly educated workers or with more skill-intensive occupations are more likely to be exporters than non-exporters. But, conditional on schooling, only the most skill-intensive professional occupations are a statistically significant predictor of next-period exporting (at the 1-percent significance level). In line with existing evidence on sunk costs of export-market entry (e.g. Roberts and Tybout (1997)), current exporting is a highly significant predictor of future exporting with a predicted marginal probability increase of roughly .2.[18] Hysteresis in exporting is better explained by a firm's presence in more export destinations than by its market penetration of given destinations. Among the exporters, firms with double the current number of export destinations have about a four times larger predicted marginal probability than firms with double the current exports per destination.[19] There is no evidence that being an affiliate

[16]The binomial exporter-nonexporter dichotomy makes this initial specification closely comparable to Clerides, Lach, and Tybout (1998), Alvarez and López (2005) or Crespi, Criscuolo, and Haskel (2008) and also to our first-stage regressions in the next Section.

[17]A conditional logit specification for firm-fixed effects performs poorly, reducing the estimation sample by more than 90 percent to only 98,731 observations and predicting an export-market participation rate of 26.2 percent, far above the actual 4.9 percent. In contrast, a linear probability model with firm-fixed effects, similar to our first-stage instrumental-variable regression below (Table 1.4) performs reasonably well, with negative predicted probabilities for just 2 percent of the sample. The linear model shows a strong association between hiring former exporter workers and export-market participation. For descriptive evidence, we limit our discussion to the more conservative estimates from binomial logit.

[18]Estimates vary from $.048(1-.048) \cdot 3.326 = .152$ in specification 1 to .218 in specification 4.

[19]The implied probability increases are $\ln(2) \cdot .048(1-.048) \cdot .579 = .018$ for export destinations and $\ln(2) \cdot .048(1-.048) \cdot .175 = .005$ for exports per destination.

of a foreign multinational enterprise (MNE) is a significant predictor of future exporting after controlling for current exporting. These estimates are highly robust across specifications.

Starting with specification 2, we investigate the predictive power of hiring former exporter workers. Whereas relative net employment expansions have no statistically significant effect on next-year exporting (at the 1-percent level), the indicator for hiring former exporter workers is highly significant. In economic terms, hiring at least one former exporter worker has a similar predictive power for future exporting (an increase of export participation by 3 percentage points) as has the share of tertiary educated workers in the workforce at current exporters.[20] This suggests that hiring key workers with an exporting background from prior employers is strongly associated with future export-market participation. Specification 3 includes the log number of gross hires from exporters, if non-zero. The included variable reduces the coefficient on the indicator for hiring former exporter workers by little and has itself a significantly positive coefficient. This suggests that it is a small number of key workers with an exporting background that matters most for the prediction. So as to understand at which firms hiring former exporter workers has the strongest predicted effect on future export-market participation, we construct an indicator variable for high-skill firms. We classify a firm as high-skill intensive if its current share of technical/supervisory and professional/managerial occupations falls into the top quartile of firm-year observations. Specification 4 includes the high-skill firm indicator and its interactions with the exporting indicator and the indicator for hiring former exporter workers. Coefficient estimates show that, at high-skill firms, the association between future exporting and hiring former exporter workers is absent. This suggests that hiring key workers with an exporting background matters most for exporting at firms with lower initial skill intensity.

To summarize, research documents that workforce characteristics differ be-

[20]The respective predictions are that hiring former exporter workers is associated with a probability increase for next-year export-market participation by $.055(1-.055) \cdot .532 = .0277$ percentage points in specification 2. By comparison, increasing the share of tertiary educated workers at exporters eightfold from .1 to .8, thus substituting the primary-educated share of the workforce (Table 1.1), is associated with a $.055(1-.055) \cdot .7 \cdot .674 = .0245$ point probability increase.

tween non-exporters and exporters. Our descriptive evidence shows in addition that export-market performance and sizes also differ markedly among exporters of different status. But commonly observed workforce characteristics such as educational attainment and occupations are quite similar among exporters despite substantive diversity in export performance and size. Instead unobserved workforce characteristics, in particular a worker's background from experience at other exporters, is an important predictor of future export-market participation. We now query to what extent the hiring of former exporter workers occurs in preparation for export-market participation.

1.4 Preparing to Export

In trade models with endogenous technology adoption such as Yeaple (2005) and Costantini and Melitz (2008), falling variable trade costs induce more firms in differentiated-goods industries to adopt innovative technology and raise their employment, hiring away from differentiated-goods producers with lower productivity (Costantini and Melitz(2008)) or hiring away the top-skilled workers from firms with inferior technology (Yeaple(2005)). The timing of hiring and technology-adoption decisions is explicitly modelled by Costantini and Melitz who show in simulations that anticipated future drops in variable trade costs lead firms to adopt innovation before the anticipated favorable trade shock manifests itself.

Estimation model. Motivated by these theories, we adopt a straightforward model of the firm's employment and export decision in two parts. First, a firm i observes export-market conditions $\mathbf{z}_{it}$ abroad at time t and uses them to linearly estimate the probability of its own future export-market participation next year $x_{i,t+1}$, conditional on its current firm characteristics and domestic market conditions $\mathbf{y}_{it}$:

$$x_{i,t+1} = \mathbf{y}_{it}'\boldsymbol{\gamma}_y + \mathbf{z}_{it}'\boldsymbol{\gamma}_z + \eta_{it}, \tag{1.1}$$

where η_{it} is a mean independent error term and $\boldsymbol{\gamma}_y$ and $\boldsymbol{\gamma}_z$ are vectors of regression coefficients. The measures of export-market conditions $\mathbf{z}_{it}$ are sector-level imports into foreign destinations (outside Latin America) from source countries other than Brazil. The idea for these foreign-demand IVs is that Brazilian firms inform themselves about foreign market conditions through the media, trade fairs, or specialized trade journals on their product markets, and follow foreign market conditions by observing their own expected residual demand.

Second, firm i uses the prediction of its future export status $\hat{x}_{i,t+1} = \mathbf{y}'_{it}\hat{\boldsymbol{\gamma}}_y + \mathbf{z}'_{it}\hat{\boldsymbol{\gamma}}_z$ to choose the number of its hires from exporters h_{it}:

$$\log(1 + h_{it}) = \mathbf{y}'_{it}\boldsymbol{\beta}_y + \hat{x}_{i,t+1}\beta_x + \epsilon_{it}, \tag{1.2}$$

where ϵ_{it} is a mean independent error term that is uncorrelated with $\mathbf{z}_{it}$, conditional on the set of covariates $\mathbf{y}_{it}$. The measure $\log(1 + h_{it})$ of log gross hiring from exporters is zero for zero hires and increases monotonically at a decreasing rate in the number of hires so that regression coefficient reflect semi-elasticities.[21] Our main hypothesis is that β_x is strictly positive. When firms observe a favorable foreign import-demand shock so that they can expect a higher chance of exporting next year, they prepare their workforces similar to technology upgrading in Costantini and Melitz (2008) and top-skill hiring in Yeaple (2005).

The control variables $\mathbf{y}_{it}$ include firm fixed effects, sector fixed effects, year fixed effects and domestic sector-level absorption (to control for a potentially co-integrated sector-level business cycle abroad and in Brazil), three indicators for the firm's current export status (to capture different degrees of persistence in export market participation), the firm's employment change between $t-1$ and t relative to employment at t (to control for total net hiring that coincides with the hiring of exporter workers), employment, workforce composition shares of worker education and occupation categories, an indicator if the firm is directly foreign owned, and an indicator if the firm is high-skill intensive (its current share of technical/supervisory

[21]We experimented with three more specifications of the left-hand side outcome in equation (1.2): $\log h_{it}$ (which is only defined for non-zero hires), h_{it}, and an indicator $\mathbf{1}(h_{it} > 0)$. Those specifications result in the same significance and sign patterns as the specifications reported below (see online Appendix). When we use exports two periods in advance, $\hat{x}_{i,t+2}$, expected exporting two years into the future is associated with about half the hiring response compared to expected exporting one year into the future but significance and sign patterns are again preserved (see online Appendix).

and professional/managerial occupations falls into the top quartile of firm-year observations). Some specifications also include sector-year trends.

Our main identifying assumption is that current foreign market conditions $\mathbf{z}_{it}$ in destinations outside Latin America affect the hiring of exporter workers h_{it} only through expected export-market participation next year (conditional on the firm's current export status, its other characteristics and domestic market conditions). While a large swing in the real exchange rate or dismantling trade barriers offers substantive variation beyond a firm's control, findings from such large-scale experiments, which can have considerable macroeconomic consequences, are arguably less instructive about exporter behavior during stable times. We therefore adopt an instrumentation strategy that relates a firm's export-market participation next year to current destination-market shocks.

Export-market shocks. There is little econometric guidance to date for the selection among multiple valid IVs when some IVs are potentially weak but others strong. If the F statistic for the hypothesis that the instrumental-variable coefficient is non-zero on the first stage surpasses a value of 10, an instrument is commonly considered a strong one (Stock, Wright, and Yogo(2002)). We have six potential IVs but need at most three IVs in later regressions. To select the strongest possible set of IVs, we use the F statistic like an information criterion. We first regress the binary future exporting indicator on all six IVs and other exogenous variables, conditioning on firm, sector and year effects. From this initial regression we select the three IVs with the highest t statistics. We then set out to add IVs in the order of their t statistics, from next highest to lowest, and observe the evolution of the F statistic as we include IVs, with the intent to stop including IVs as soon as the F statistic starts falling. We find the import-demand IVs of OIN, WEU and NAM to have similarly high t statistics (between 3.9 and 3.4 in absolute value) and then add CEE to the regression, which has the next highest t statistic (1.7 in absolute value). With this addition, the F statistic for joint significance of the IVs drops, however, from 18.0 to 14.1. We therefore use no IVs other than import demand in OIN, WEU and NAM.

The upper panel (A) in Table 1.4 shows the results from linear regressions of future exporting on these pure demand IVs, conditional on our set of control variables.[22] There is no a priori expected sign for coefficients on our foreign import-demand measures. A positive sign is consistent with favorable consumer demand conditions at the foreign destination both for Brazilian and non-Brazilian exporters. A negative sign is consistent with unfavorable residual demand at the foreign destination for Brazilian exporters in the wake of large competing shipments by non-Brazilian export countries. By this interpretation of coefficients in Table 1.4, shipments from non-Brazilian export countries to North America and other industrialized countries tend to substitute Brazilian exports whereas others' shipments to Western Europe tend to complement Brazilian exports (columns 1 through 3). Expectedly, signs of significant coefficients are reversed for Brazilian firms that quit exporting (column 4).

Foreign market conditions $\mathbf{z}_{it}$ vary by sector and year and capture pure demand effects, which are common to all firms within a sector. While instrument validity is unaffected by this limited variation, predictive power of the IVs can be a concern. The F statistic clearly exceeds 10 for the binary future exporter indicator and for export starters, but the F statistic falls below the threshold of 10 for continuous exporting status and for firms that quit exporting. We will therefore interpret second-stage results for continuous exporters and export quitters with caution.

In the presence of sunk entry costs the firms' responses to changing foreign market conditions depend on the firm's current export status (Dixit(1989)). Among the control variables $\mathbf{y}_{it}$ we include the firm's current export status, thus capturing the direct effect of current exporting on hiring exporter workers on the second stage (1.2). As a consequence, the joint effect of worldwide market conditions and the vector of current export status indicators $z_{it}^{ww}\mathbf{x}_{it}$ are valid instruments as long as persistent firm-level export-supply shocks are summarized by the current export status and hence do not confound second-stage estimation. We exclude imports into any Latin American economy from the measure of worldwide imports

[22]Firms are not nested within sectors in our data so sector fixed effects are separately identified but common clustering of standard errors in the two-stage least squares regression becomes inviable.

z_{it}^{ww} and interact worldwide import demand with indicators for the three export status categories other than non-exporters (Table 1.1).

The middle panel (B) in Table 1.4 shows the results for the first-stage of the according interacted instrumental variable regression. Expectedly, the F statistics now far exceed the threshold of 10. In the lower panel (C) in Table 1.4, we introduce sector-year trends in addition and the F statistics remain above the threshold of 10.[23] The identifying assumption for the new set of instruments (B and C) is more restrictive. So we will check second-stage estimates from the alternative sets of instruments (A-C) against each other to assess robustness and query their implied validity.

Hiring away exporter workers. We now consider the hiring of former exporter workers at time t as a preparation for export-market participation in the next year. For this purpose, we use expected export-market participation at $t+1$, predicted by the above-mentioned observed foreign import-demand shocks at t.

Results in Table 1.5 show that expected future exporting is significantly positively associated with advance hiring of former exporter workers across all four specifications, irrespective of instrumentation. In magnitude, coefficient estimates are strictly larger when future exporting is instrumented (columns 2 through 4) than in ordinary regression (column 1). Note that our IV regressions measure the effect of expected future export-market participation (the treatment) on responding firms that are susceptible to favorable foreign demand conditions (treatment responders). In contrast, the ordinary regression (column 1) measures the covariation of observed future export-market participation on the universe of firms, including the bulk of never-exporting firms that are not susceptible to favorable foreign demand (never-responders). So coefficients in IV regressions expectedly exceed those from ordinary regression. We will provide evidence on the most responsive firms below, consistent with this interpretation (Table 1.6).

Using pure foreign-demand IVs (column 2) predicts that firms prepare for an expected 10 percentage-point increase in the probability of export-market par-

[23] Sector-year trends would depress F statistics below 10 in the upper panel of Table 1.4 (see online Appendix).

ticipation next year with one gross hire of former exporter workers in advance at the sample mean.[24] This is a plausible number. The average firm in the sample exports with a probability of 4.9 percent (Table 1.1). The average exporter contracts twelve former exporter workers per year during the sample period, while recent export quitters just hire three former exporter workers on average and the mean manufacturing firm just hires one (Table 1.1). Using foreign-demand IVs interacted with the firm's present export status (columns 3 and 4), leads to a smaller magnitude: by this measure, an expected 10 percentage-point increase in the exporting probability next year results in advance gross hiring of only .4 former exporter workers.

Interestingly, numerous coefficients on covariates are consistent with the interpretation that strong firm-side performance up to the current year is not typically associated with hiring former exporter workers. Continuous exporting firms and recent export starters hire strictly fewer former exporter workers than non-exporters, whereas firms that just quit exporting in the current period contract more former exporter workers, arguably in anticipation of a mean reversion in their export participation. Similarly, firms with more tertiary educated workers and a higher skill intensity hire strictly fewer former exporter workers (with a minor coefficient alteration for the fraction of exporters among high skill intensive firms). As the only exception to the overall pattern, a larger share of skill-intensive white-collar occupations is associated with hiring more former exporter workers, conditional on the education composition of the workforce and the firm's rank in the skill intensity distribution. The overall pattern broadly supports the interpretation that initially less well staffed firms pursue the strongest advance hiring of former exporter workers.

A comparison of results from the three different sets of instruments (A-C) shows that signs and significance patterns are highly robust across specifications (columns 2 through 4), with signs identical when significant for thirteen out of

[24]By the coefficient estimate in column 2, implied gross hiring of former exporter workers is $.1 \cdot 4.549 \cdot (1 + \bar{h}) = .96$ workers for a 10 percentage-point increase in the exporting probability and mean former exporter hires $\bar{h} = 1.1$ (Table 1.1). It is $.1 \cdot 2.055 \cdot (1 + \bar{h}) = .43$ by column 3 and $.1 \cdot 1.745 \cdot (1 + \bar{h}) = .37$ by column 4.

fifteen covariates. Given robustness across sets of instruments, we now return to the difference in coefficient magnitudes between the instrumented and non-instrumented variables. To assess our explanation, we investigate which firms most responsively hire former exporter workers.

Hiring away exporter workers by region and firm size. We interact the indicator of exporting one year in advance with the firm's location in one of three broad regions in Brazil, having three instruments at hand. São Paulo state is Brazil's manufacturing center, hosting about half of Brazil's manufacturing value added during the 1990s. The South and South East of Brazil (excluding São Paulo state) exhibit higher per-capita incomes than the North, North East and Center West, but neither the South nor the remaining South East (Rio de Janeiro, Minas Gerais and Espírito Santo) can match São Paulo's concentration of manufacturing industries.

Results in the upper panel of Table 1.6 corroborate our earlier interpretation that instrumented regressions reflect the responses of firms that are susceptible to favorable foreign demand conditions. We ignore results from the relatively weak set of instruments (A in column 2). Only firms in São Paulo state significantly respond to favorable foreign demand by hiring away exporter workers (columns 3 and 4). Arguably only the industry agglomeration in São Paulo offers a sufficiently thick labor market to permit effective worker poaching.

We also interact the indicator of exporting one year in advance with the firm's log size. Results in the lower panel of Table 1.6 for this interaction provide further evidence in favor of our interpretation of firm responsiveness (columns 3 and 4). Only relatively large firms with an arguably strong competitive advantage respond to favorable foreign demand conditions by hiring former exporter workers.

Hiring away exporter workers by expected export status. Theory implies that firms with the largest anticipated gains from exporting have the strongest incentive to engage in preparatory investments and hiring (Yeaple(2005),Costantini and Melitz(2008)). One proxy to returns from export-market participation is the expected exporter category, with continuous exporters arguably locking in larger gains than export starters. We accordingly estimate equation 1.1 for a vector of expected exporter status over three categories.

Table 1.7 reports the results (first stages shown in Table 1.4, column 2 through 4). We ignore results from the relatively weak set of instruments (A in column 2), which produce a poor R^2 fit. As theory suggests, expected continuous exporters exhibit the strongest response in hiring former exporter workers, and export starters an intermediate response. Compared to non-exporters, firms that are predicted to quit exporting given foreign demand shocks still hire significantly more former exporter workers. That sign is not what we expected. Note, however, that for a firm to be a quitter next year it must be an exporter this year. A consistent interpretation of the sign then is that current exporters whose foreign demand shocks predict export-market exit next period may still have a stronger incentive to poach former exporter workers than non-exporters because a current exporter's expected returns from catching up to well staffed exporters, and re-entering the export market subsequently, are larger than for the bulk of never-exporters in the sample.

Firing recent exporter hires upon unexpected export failure. Regression specifications so far offer evidence for our main hypothesis that a firm hires away exporter workers when it can expect to export next year. A corollary of our hypothesis is that a firm with favorable foreign-demand conditions, which currently predict a high probability of export-market participation next year, should lay off again its currently poached hires from exporters if it fails to become an exporter by next year. To pursue this placebo-like treatment, we follow recent hires from exporters in the current year into the next calendar year and identify separations that occur before the end of the next calendar year. We define *separations of recent exporter hires* as hires from exporters in the current year whose new employment terminates before December 31st of the next year. We then restrict the firm sample in two ways. First, we keep only those firm observations whose predicted export indicator for next year is above the sample median, consistent with a favorable expectation of export-market participation. Of those firm observations, we only keep the ones that turn out to be non-exporters next year. Second, we keep only firm observations with predicted exporting next year above the 75th percentile, and of those only the non-exporters next year.

For each restricted sample of unexpectedly failing exporters, we replicate equation 1.2 and regress separations from current exporter hires $\log(1 + s_{i,t+1})$ on the prediction of the firm's future export status $\hat{x}_{i,t+1}$ and the control variables. We know from estimates of equation 1.2 that a higher propensity of exporting next year leads to more hires of exporter workers in the current year. If those hires mainly serve for export-market entry, and little else, then we should expect in the restricted sample of unexpectedly failing exporters that a higher propensity of exporting next year leads to more firings of these recently hired exporter workers over the next year. Results in Table 1.8 corroborate exactly this implication. The coefficient estimate on the exporting predictor for next year is strictly positive. So unexpectedly failing exporters fire more recent exporter hires if the exporting predictor induced them to poach more exporter workers in the current year. Given our endogenous sample restriction based on first-stage estimates, we bootstrap the standard errors over both estimation stages. The coefficients are statistically significant at the one-percent level in the larger sample with the median export indicator as the cutoff for a firm's predicted export indicator (and at the five-percent level in the smaller sample for instrument set B). Comparing estimates in the upper panel of Table 1.8 to the hiring estimates (Table 1.5) suggests that unexpectedly failing exporters let go again of between one-third to 90 percent of the recently poached hires from exporters.[25]

In summary, firms hire former exporter workers in advance of expected favorable export conditions, and especially firms in regions with thick manufacturing labor markets contract exporter workers in response to expected export-market participation. Large firms and firms that anticipate to become continuous exporters pursue relatively more such advance hires. Conversely, unexpectedly failing exporters lay off a significant fraction of their recently hired former exporter workers. We now return to a descriptive investigation into the importance of advance hiring of exporter workers for a firm's performance in foreign markets.

[25]The coefficient ratios range from .36 and .37 under instrument sets (B) and (C) to .89 under instrument set (A).

1.5 Predictors of Exporter Performance

Performance after hiring away exporter workers. We now restrict the sample to exporters only and seek additional evidence on two aspects of exporter performance. We decompose the log of a firm's exports into the log number of its export destinations (market reach) and its log exports per destination (market penetration). We relate these two outcomes next year to the firm's present characteristics, including its hires of former exporter workers.

Table 1.9 shows two sets of three regressions for exporting firms, one set with the log number of destinations as dependent variable (columns 1 through 3) and one set with the log exports per destination as dependent variable (columns 4 through 6). Each regression conditions on the other outcome variable to isolate the covariation of predictors. A firm's workforce characteristics exhibit similar covariations with the outcomes as in our binomial regression of exporting on current characteristics (Table 1.3), so we suppress the workforce shares and the MNE indicator for brevity.

In a short regression, neither the indicator for hiring former exporter workers nor the log number of hired exporter workers are significant predictors of market reach at the 1-percent significance level (column 1). The log number of hired exporter workers, however, is a significant predictor of export-market penetration in a short regression (column 4). We next bring to bear exporter categories in our data to discern between hires from continuous exporters and hires from recent export starters. For both outcomes at the hiring firm, market reach (column 2) and market penetration (column 5), now the log number of workers hired from continuous exporters is a significant predictor of better export performance, but not the number of hires from export starters. This finding is consistent with the idea that workers with a background at continuous exporters have unobserved characteristics that are more important for reaching more destinations and deeper into destination than workers just with prior experience at recent export starters.

Finally, we bring to bear both additional worker-level and exporter information in our data to gain more detailed insight from long regressions. Among the hires from exporters, mostly workers in marketing occupations at the prior employer predict a wider market reach at the hiring firm (column 3) but not a deeper export-market penetration (column 6). Mostly workers in skilled blue-collar occupations at the prior employer predict a deeper market penetration by the hiring firm (column 6) but not a wider export-market reach (column 3). A larger overlap of export destinations between the prior employer and the current employer predicts a higher success for both market reach and penetration at the hiring firm. These findings are consistent with the idea that workers bring with them destination-specific knowledge. The findings also invite speculation that salespersons may be more important to reach additional destinations (perhaps because they know market characteristics and clients), whereas production skills (perhaps for high quality and timely delivery) are more relevant for deeper penetration of a market with additional sales.

Performance after departures of workers to exporters. For a final investigation as to how knowledge may move with workers, we consider the effect of departing workers on an exporter's success. For this purpose, we track a worker who separates from a firm to the immediately following formal-sector employment for up to three subsequent years and obtain the future employer's export status (mirroring the definition for hires from exporters). This allows us to define *departures to exporters* as separating workers whose following formal-sector employment is at an exporter.

We include an indicator for such worker departures to exporters and the log number of departures to exporters as additional regressors into the specifications of market reach and market penetration before. Table 1.10 reports the results for the two new variables. Remarkably, the log number of departures is a significant predictor only for market penetration (in the specification of column 6). A consistent interpretation is that current exporters might only suffer a significant loss in market penetration but not in market reach, once they know how to access a given set of foreign markets.

This result is interesting in at least two regards. First, the result offers a potential explanation why worker poaching can be successful. While the hiring firm may expect to improve export outcomes in two dimensions, both regarding market reach and market penetration, the losing firm may expect to suffer only in the dimension of market penetration. This difference in product-market outcomes potentially raises the marginal product of the poached worker for the hiring firm above the value for the losing firm. Second, the result offers suggests that worker mobility may be an efficient mechanism by which knowledge spreads through an economy. If the moving worker's marginal product increases with the move, the spread of knowledge is welfare improving.

1.6 Concluding Remarks

Using rich linked employer-employee data that track Brazilian manufacturing firms, their exports and individual workers over more than a decade, we document substantive size and performance differences among exporters, not just between exporters and non-exporters. Despite this diversity in export-market performance and employment, the workforce composition varies little among exporters. Looking into typically unobserved aspects of workers' job histories, we find that hiring a small number of former exporter workers is an important predictor of a firm's export-market success. To measure the extent of active workforce preparations for future exporting, we use import demands for non-Brazilian goods outside Latin America as instruments. We find that firms hire former exporter workers in response to favorable demand conditions abroad and in advance of expected export-market entry.

Hiring workers from marketing-related occupations at former exporters predicts a wider reach of destinations, and hiring skilled blue-collar workers from exporters predicts a deeper penetration of destinations. Yet the exact origins of former exporter workers' skills remain a matter for future research. Former exporter workers may have special skills from passive learning or active training at former exporters, they may know individual clients or have broad insight into destination-market characteristics, or their prior exporter employment may simply signal a screened ability.

Our results are consistent with the idea that firms, especially firms with long-term export potential, actively contract a competitive workforce to add to their initial advantage, and then select to export. So firms prepare for expected export-market participation through prior workforce upgrading. These workforce preparations are consistent with recent trade models where firms can both choose export-market participation and engage in innovation, while each activity raises the return to the other. So a firm's competitive advantage is partly under its own control, and firms share in an economy's knowledge pool through mobile workers.

This chapter was written jointly with Professor Marc Muendler.

1.7 Bibliography

Alvarez, R., and R. A. López (2005): "Exporting and performance: evidence from Chilean plants," *Canadian Journal of Economics/Revue canadienne d'Ãl'conomique*, 38(4), 1384–1400.

——— (2008): "Is Exporting a Source of Productivity Spillovers?," *Review of World Economics (Weltwirtschaftliches Archiv)*, 144(4), 723–749.

Atkeson, A., and A. Burstein (2008): "Pricing-to-Market, Trade Costs, and International Relative Prices," *American Economic Review*, 98(5), 1998–2031.

Aw, B. Y., M. J. Roberts, and D. Y. Xu (2011): "R&D Investment, Exporting, and Productivity Dynamics," *American Economic Review*, 101(4), 1312–44.

Bernard, A. B., and J. Bradford Jensen (1999): "Exceptional exporter performance: cause, effect, or both?," *Journal of International Economics*, 47(1), 1–25.

Bernard, A. B., and B. J. Jensen (1995): "Exporters, Jobs, and Wages in U.S. Manufacturing: 1976-1987," *Brookings Papers on Economic Activity: Microeconomics*, 1995(1), 67–112.

Bernard, A. B., J. B. Jensen, S. J. Redding, and P. K. Schott (2007): "Firms in International Trade," *Journal of Economic Perspectives*, 21(3), 105–130.

Bernard, A. B., J. B. Jensen, and P. K. Schott (2009): "Importers, Exporters and Multinationals: A Portrait of Firms in the U.S. that Trade Goods," in *Producer Dynamics: New Evidence from Micro Data*, NBER Chapters, pp. 513–552. National Bureau of Economic Research, Inc.

Brooks, E. L. (2006): "Why don't firms export more? Product quality and Colombian plants," *Journal of Development Economics*, 80(1), 160–178.

Bustos, P. (2011): "Trade Liberalization, Exports, and Technology Upgrading: Evidence on the Impact of MERCOSUR on Argentinian Firms," *American Economic Review*, 101(1), 304–40.

Clerides, S. K., S. Lach, and J. R. Tybout (1998): "Is Learning By Exporting Important? Micro-Dynamic Evidence From Colombia, Mexico, And Morocco," *The Quarterly Journal of Economics*, 113(3), 903–947.

Costantini, J., and M. Melitz (2008): *The Dynamics of Firm-Level Adjustment to Trade Liberalization,*chap. 4, pp. 107–141. Cambridge, Mass:Harvard Unversity Press.

Crespi, G., C. Criscuolo, and J. Haskel (2008): "Productivity, exporting, and the learning-by-exporting hypothesis: direct evidence from UK firms," *Canadian Journal of Economics*, 41(2), 619–638.

Dixit, A. K. (1989): "Hysteresis, Import Penetration, and Exchange Rate Pass-Through," *The Quarterly Journal of Economics*, 104(2), 205–28.

Ederington, J., and P. McCalman (2008): "Endogenous firm heterogeneity and the dynamics of trade liberalization," *Journal of International Economics*, 74(2), 422 – 440.

Feenstra, R. C., R. E. Lipsey, H. Deng, A. C. Ma, and H. Mo (2005): "World Trade Flows: 1962-2000," NBER Working Papers 11040, National Bureau of Economic Research, Inc.

Frías, J. A., D. S. Kaplan, and E. A. Verhoogen (2009): "Exports and Wage Premia: Evidence from Mexican Employer-Employee Data," .

Gershenberg, I. (1987): "The training and spread of managerial know-how, a comparative analysis of multinational and other firms in Kenya," *World Development*, 15(7), 931–939.

Görg, H., and E. Strobl (2005): "Spillovers from Foreign Firms through Worker Mobility: An Empirical Investigation," *Scandinavian Journal of Economics*, 107(4), 693–709.

Granger, C. W. J. (1969): "Investigating Causal Relations by Econometric Models and Cross-Spectral Methods," *Econometrica*, 37(3), 424–38.

Hopenhayn, H. A. (1992): "Entry, Exit, and Firm Dynamics in Long Run Equilibrium," *Econometrica*, 60(5), 1127–50.

Iacovone, L., and B. Javorcik (2012): "Getting Ready: Preparation for Exporting," CEPR Discussion Papers 8926, C.E.P.R. Discussion Papers.

Isgut, A. (2001): "What's Different about Exporters? Evidence from Colombian Manufacturing," *Journal of Development Studies*, 37(5), 57–82.

López, R. A. (2009): "Do Firms Increase Productivity in Order to Become Exporters?," *Oxford Bulletin of Economics and Statistics*, 71(5), 621–642.

Melitz, M. J. (2003): "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity," *Econometrica*, 71(6), 1695–1725.

Poole, J. P. (2012): "Knowledge Transfers from Multinational to Domestic Firms: Evidence from Worker Mobility," *Review of Economics and Statistics*, forthcoming.

Rhee, Y. W. (1990): "The catalyst model of development: Lessons from Bangladesh's success with garment exports," *World Development*, 18(2), 333–346.

Roberts, M. J., and J. R. Tybout (1997): "The Decision to Export in Colombia: An Empirical Model of Entry with Sunk Costs," *American Economic Review*, 87(4), 545–64.

Stock, J. H., J. H. Wright, and M. Yogo (2002): "A Survey of Weak Instruments and Weak Identification in Generalized Method of Moments," *Journal of Business & Economic Statistics*, 20(4), 518–29.

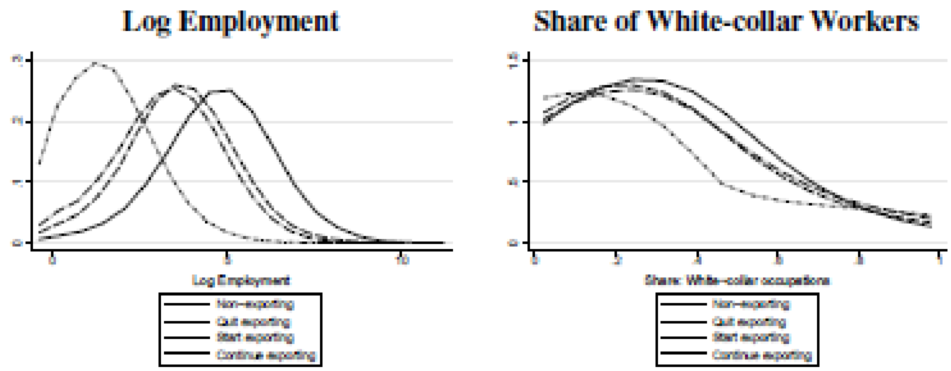
Trefler, D. (2004): "The Long and Short of the Canada-U. S. Free Trade Agreement," *American Economic Review*, 94(4), 870–895.

Van Biesebroeck, J. (2005): "Exporting raises productivity in sub-Saharan African manufacturing firms," *Journal of International Economics*, 67(2), 373–391.

Verhoogen, E. A. (2008): "Trade, Quality Upgrading, and Wage Inequality in the Mexican Manufacturing Sector," *The Quarterly Journal of Economics*, 123(2), 489–530.

Yeaple, S. R. (2005): "A simple model of firm heterogeneity, international trade, and wages," *Journal of International Economics*, 65(1), 1 – 20.

Figures



Sources: SECEX and RAIS 1992 − 2001, manufacturing firms (subsectors IBGE 2 − 13).

Note: Export status as defined in Table 1.1. Workforces on December 31st. Epanechnikov kernels with band-widths .4 (employment) and .2 (white-collar occupations).

Figure 1.1: Density Estimates of Sizes and White-collar Shares

Tables

Table 1.1: Export Status Ordering

Export status	Export period t-2	t-1	t	Firm-year observations (1)	Workers per firm (2)	Annual exports (3)
Non-Exporter						
Permanent non-exporter[a]	0	0	0	1,596,947	12	
Current non-exporter[a]	0	0	0	60,198	66	
Quit-Exporting						
Past quitter	1	0	0	9,101	79	
In-out switcher	0	1	0	7,626	76	
Recent quitter	1	1	0	6,569	102	
Start-Exporting						
Recent starter	0	0	1	18,420	104	310.7
Re-entrant	1	0	1	3,181	137	231.0
Past starter	0	1	1	12,252	149	923.1
Continuous-Exporting						
Non-sustained continuous exporter[b]	1	1	1	6,044	178	561.3
Sustained non-OECD exporter[b]	1	1	1	21,915	232	888.4
Sustained OECD exporter[b]	1	1	1	25,238	552	10,802.7

[a]Permanent non-exporters do not export in any sample year; current non-exporters export in at least one sample year.

[b]Non-sustained continuous exporters export in three consecutive years but serve no single destination in all three years; sustained non-OECD exporters serve at least one destination (but no 1990-OECD member country) in three consecutive years; sustained OECD exporters serve at least one 1990-OECD member country in all three years.

Source: SECEX 1990 through 2001 ($t : 1992 - 2001$), manufacturing firms (subsectors IBGE $2 - 13$).

Notes: Universe of $1,767,491$ manufacturing firm-year observations. Exports (fob) in thousands of August 1994 USD.

Table 1.2: Exporter Premia Conditional on Log Firm Size

Firm characteristic	Export Status Continuous (1)	 Start (2)	 Quit (3)	t-tests of null-hypothesis (1) == (2)	 (2) == (3)
Earnings					
Log Annual Wage	.440	.307	.316	≠	
	(.003)	(.003)	(.004)		
Residual Log Annual Wage	.351	.248	.256	≠	
	(.003)	(.003)	(.003)		
Workforce composition					
Share: Unsk. blue-collar occ.	-.021	-.003	-.001	≠	
	(.001)	(.001)	(.002)		
Share: Skilled blue-collar occ.	-.081	-.070	-.085	≠	≠
	(.001)	(.002)	(.002)		
Share: White-collar occ.	.102	.073	.086	≠	≠
	(.001)	(.001)	(.002)		
Share: Primary school education	-.111	-.076	-.061	≠	≠
	(.001)	(.001)	(.002)		
Share: High school education	.047	.034	.021	≠	≠
	(.0009)	(.001)	(.001)		
Share: Tertiary education	.064	.042	.040	≠	
	(.0006)	(.0008)	(.001)		
Workforce background					
Log Gross Hires from Exp.	.834	.475	.185	≠	≠
	(.005)	(.005)	(.005)		

Sources: SECEX and RAIS 1992 − 2001, manufacturing firms (subsectors IBGE 2 − 13).

Notes: Premia and coefficients from linear regressions of the firm characteristics on export status dummies, controling from the firms' log employment, sector and year effects in the universe of 1,767,491 manufacturing firm-year observations. Export status as defined in table 1.1. The omitted baseline category is non-exporters for three years. Workforces on December 31st. Annualized December wages in thousands of August-1994 USD, residual log wage from a linear regression on educational and occupational workforce composition variables. Log number of gross hires from exporters set to missing if zero. Robust standard error in parentheses. Inn columns 4 and 5, rejection of the null hypothesis of equality are reported for t tests at 1-percent significance.

Table 1.3: Logit Prediction of Future Export-Market Participation

	Exporter $(t+1)$			
Predictor (t)	(1)	(2)	(3)	(4)
Log Employment	.673	.566	.568	.518
	(.005)*	(.006)*	(.007)*	(.007)*
Share: High school education	.248	.214	.214	.230
	(.027)*	(.029)*	(.030)*	(.030)*
Share: Tertiary education	.818	.674	.675	.731
	(.047)*	(.053)*	(.053)*	(.053)*
Share: Skilled blue-collar occ.	-.224	-.207	-.207	-.168
	(.026)*	(.028)*	(.028)*	(.028)*
Share: Other white-collar occ.	-.046	-.032	-.033	-.084
	(.050)	(.054)	(.054)	(.056)
Share: Techn. or supervis. occ.	-.028	.017	.017	-.147
	(.041)	(.045)	(.045)	(.059)
Share: Profess. or manag'l.occ.	.597	.516	.516	.327
	(.058)*	(.066)*	(.066)*	(.077)*
Indic.:Exporter	3.326	3.286	3.286	4.261
	(.025)*	(.026)*	(.026)*	(.032)*
Log # Destinations	.579	.620	.621	.670
	(.018)*	(.019)*	(.019)*	(.018)*
Log Exports/Destination	.175	.176	.176	.190
	(.007)*	(.007)*	(.007)*	(.007)*
Indic.: Affiliate of foreign MNE	-.351	-.243	-.242	-.265
	(.482)	(.474)	(.474)	(.432)
Rel. Employment Chg. ($t-1$ to t per t)		.007	.007	.012
		(.004)	(.004)	(.005)
Indic.: Hires from Exporters		.532	.536	1.121
		(.016)*	(.017)*	(.021)*
Log Gross Hires from Exp.			-.007	.056
			(.011)	(.010)*
Indic.:High-skill firm				.296
				(.028)*
Indic.:High-skill firm × Indic.:Exporter				-.512
				(.030)*
Indic.:High-skill firm × Hires from Exporter				-1.439
				(.030)*
Observations	1,557,474	1,284,996	1,284,996	1,284,996
Pseudo R^2	.628	.637	.637	.642
Predicted probability $\widehat{P}$	.048	.055	.055	.055

Sources: SECEX and RAIS 1992 – 2001, manufacturing firms (subsectors IBGE 2 – 13).

Notes: Logit regressions, controlling for sector and year effects, and sectoral absorption. Binary present and future exporter indicators represent firms that start exporting and that continue exporting. Workforces on December 31st. Exports (fob) n thousands of August-1994 USD. Log number of destinations and log exports per destination set to zero for non-exporters. Log number of gross hires from exporters set to zero if zero hires. High-skill firms are firms with share of technical/supervisory and professional/managerial occupations in top quartile of firm-year observations. Robust standard errors in parentheses; asterisk marks significance at 1-percent level.

Table 1.4: Foreign Demand and Future Export-Market Participation

	Exporter	Export Status($t+1$)		
	$t+1$	Continuous	Start	Quit
Instrument(t)	(1)	(2)	(3)	(4)
A:Sectoral Foreign Imports by Region, no trend (IV)				
Non-Brazil Imports in NAM	-.037	.013	-.051	-.002
	(.014)*	(.009)	(.012)*	(.011)*
Non-Brazil Imports in OIN	-.185	-.119	-.066	.067
	(.041)*	(.028)*	(.037)	(.032)
Non-Brazil Imports in WEU	.032	.006	.026	-.027
	(.010)*	(.007)	(.009)*	(.008)*
Observations	1,284,996	1,284,996	1,284,996	1,284,996
$R^2(within)$	.044	.219	.083	.198
F statistic	19.65	6.43	13.61	8.09
B:Sectoral Foreign Imports × Exporter Status, no trend (IV×Exp.)				
Non-Brazil Imports WW × Cont. Exp.	-.083	-.037	-.046	.037
	(.002)*	(.002)*	(.002)*	(.002)*
Non-Brazil Imports WW × Start. Exp.	-.063	-.009	-.054	.032
	(.002)*	(.002)*	(.002)*	(.002)*
Non-Brazil Imports WW × Quit. Exp.	-.022	-.008	-.014	-.018
	(.002)*	(.002)*	(.002)*	(.002)*
Observations	1,284,996	1,284,996	1,284,996	1,284,996
$R^2(within)$	.046	.219	.084	.198
F statistic	546.00	186.25	305.03	299.01
C:Sectoral Foreign Imports × Exporter Status, with sector trend (IV×Exp.)				
Non-Brazil Imports WW × Cont. Exp.	-.085	-.039	-.047	.041
	(.002)*	(.002)*	(.002)*	(.002)*
Non-Brazil Imports WW × Start Exp.	-.064	-.010	-.054	.034
	(.002)*	(.002)*	(.002)*	(.002)*
Non-Brazil Imports WW × Quit Exp.	-.023	-.009	-.015	-.016
	(.002)*	(.002)*	(.002)*	(.002)*
Observations	1,284,996	1,284,996	1,284,996	1,284,996
$R^2(within)$	.046	.220	.084	.198
F statistic	536.34	190.13	294.86	318.45

Sources: SECEX and RAIS $1990-2001$ ($t: 1992-2001$), manufacturing firms (subsectors IBGE $2-13$).

Notes: Linear regressions, controlling for firms fixed effects, sector and year effects, and sectoral absorption, panel C also controlling for linear sector trends. Binary future exporter indicators represent firms that start exporting at $t+1$ or that continue exporting. at $t+1$; future and current export status as defined in Table 1.1. Non-Brazilian imports in Other Industrialized countries (OIN), Western European countries (WEU), North American countries (NAM excluding Mexico), and worldwide (WW excluding Latin America and Caribbean). Additional regressors: current export status, workforce characteristics and MNE indicator as in Table 1.2. Standard errors in parentheses; asterisk marks significance at 1-percent level.

Table 1.5: Hires from Exporters

	Log[1 + Hires from Exporters](t)			
		IV	IV×Exp.	
	FE	FE(A)	FE(B)	FE, trend(C)
Predictor($t$unless noted otherwise)	(1)	(2)	(3)	(4)
Indic:Anticip. Exporter ($t+1$)	.119	4.549	2.055	1.745
instr. in (2) − (4)	(.003)*	(.669)*	(.080)*	(.076)*
Indic.:Continue Exporting	.044	-.579	-.228	-.178
	(.004)*	(.095)*	(.013)*	(.012)*
Indic.:Start Exporting	.081	-.713	-.266	-.208
	(.003)*	(.120)*	(.015)*	(.014)*
Indic.:Quit Exporting	-.032	.278	.104	.086
	(.003)*	(.047)*	(.007)*	(.007)*
Rel. Employment Chg. ($t-1$to$t$per$t$)	.002	-.00007	.0009	.001
	(.000006)*	(.0003)	(.00008)*	(.00008)*
Log Employment	.230	.141	.191	.197
	(.0007)*	(.013)*	(.002)*	(.002)*
Share: High school education	.005	-.005	.0005	.002
	(.002)	(.004)	(.002)	(.002)
Share: Tertiary education	-.025	-.027	-.026	-.025
	(.004)*	(.007)*	(.005)*	(.004)*
Skilled blue-collar occ.	-.006	-.019	-.012	-.011
	(.002)	(.005)*	(.003)*	(.003)*
Other white-collar occ.	-.064	-.053	-.059	-.061
	(.004)*	(.009)*	(.005)*	(.005)*
Techn. or supervis. occ.	.036	.041	.038	.038
	(.004)*	(.008)*	(.005)*	(.005)*
Profess. or manag'l. occ.	.009	.047	.026	.022
	(.006)	(.013)*	(.007)*	(.007)*
Affiliate of foreign MNE	.035	.101	.064	.060
	(.038)*	(.076)*	(.047)*	(.045)*
Indic: High-skill firm	-.052	-.071	-.060	-.059
	(.002)*	(.005)*	(.002)*	(.002)*
Indic: High-skill firm × Exporter	-.103	.105	-.012	-.027
	(.004)*	(.033)*	(.007)	(.006)*
Observations	1,284,996	1,284,996	1,284,996	1,284,996
R^2(*overall*)	.453	.296	.404	.423

Sources: SECEX and RAIS 1990 − 2001 (t : 1992 − 2001), manufacturing firms (subsectors IBGE 2 − 13).
Notes: Linear regressions, controlling for firms fixed effects, sector and year effects, and sectoral absorption; linear sector trends in specification 4. Specifications 2, 3 and 4 use instrumented binary future exporter indicator (column 1 of Table 1.4). Binary future exporter indicator represents firms that start exporting at $t+1$ or that continue exporting. at $t+1$; current export status as defined in Table 1.1. Workforces on December 31st. High- skill firms are firms with share of technical/supervisory and professional/managerial occupations in top quartile of firm-year observations. Standard errors in parentheses; asterisk marks significance at 1-percent level.

Table 1.6: Hires from Exporters with Region and Size Interactions

	Log[1 + Hires from Exporters](t)			
		IV	IV×Exp.	
	FE	FE(A)	FE(B)	FE, trend(C)
Predictor($t$unless noted otherwise)	(1)	(2)	(3)	(4)
Regional Interactions				
Indic:Anticip. Exp. $(t+1)$	.104	-11.053	2.963	2.549
instr. in São Pablo	(.004)*	(32.948)	(.223)*	(.193)*
Indic:Anticip. Exp. $(t+1)$	.127	-34.345	2.015	1.448
instr. in South/SouthEast	(.004)*	(159.413)	(.864)	(.841)
Indic:Anticip. Exp. $(t+1)$	.159	-301.604	.841	1.732
instr. in North/NorthEast/CenterWest	(.009)*	(746.287)	(2.951)	(2.814)
Observations	1,284,670	1,284,670	1,284,670	1,284,670
R^2(*overall*)	.453	.026	.359	.382
Log Size Interaction				
Indic:Anticip. Exp. $(t+1)$	-.605	-12.145	-.168	-.091
	(.007)*	(1.604)*	(.475)	(.460)
Log Employment	.220	.095	.183	.189
	(.0007)*	(.014)*	(.002)*	(.002)*
Indic:Anticip. Exp. $(t+1)$	.189	3.001	.419	.351
× Log Employment	(.002)*	(.261)*	(.088)*	(.087)*
Observations	1,284,996	1,284,996	1,284,996	1,284,996
R^2(*overall*)	.498	.233	.489	.498

Sources: SECEX and RAIS $1990-2001$ ($t: 1992-2001$), manufacturing firms (subsectors IBGE $2-13$).

Notes: Linear regressions, controlling for firms fixed effects, sector and year effects, and sectoral absorption; for linear sector trends in specification 4. 1,284,996 observations. Specifications 2, 3 and 4 use instrumented binary future exporter indicator (column 1 of Table 1.4). Additional regressors: current export status as defined in Table 1.1, workforce and MNE control variables as in Table 1.5. Standard errors in parentheses; asterisk marks significance at 1-percent level.

Table 1.7: Hires from Exporters and Anticipated Export Status

	Log[1 + Hires from Exporters](t)			
		IV	IV×Exp.	
	FE	FE(A)	FE(B)	FE, trend(C)
Predictor($t$unless noted otherwise)	(1)	(2)	(3)	(4)
Anticip. Continue Exporting ($t+1$)	.177	4.468	3.921	3.366
instr. in (2) − (4)	(.005)*	(4.520)	(.300)*	(.279)*
Anticip. Start Exporting ($t+1$)	.111	2.960	2.300	1.913
instr. in (2) − (4)	(.003)*	(2.397)	(.250)*	(.247)*
Anticip. Quit Exporting ($t+1$)	.035	16.128	1.654	1.302
instr. in (2) − (4)	(.004)*	(3.308)*	(.287)*	(.281)*
Observations	1,284,996	1,284,996	1,284,996	1,284,996
$R^2(overall)$	.454	.002	.362	.386

Sources: SECEX and RAIS 1990 − 2001 (t : 1992 − 2001), manufacturing firms (subsectors IBGE 2 − 13).

Notes: Linear regressions, controlling for firms fixed effects, sector and year effects, and sectoral absorption; for linear sector trends in specification 4. Specifications 2, 3 and 4 use instrumented binary future exporter indicator (columns 2 through 4 of Table 1.4). Future and current export status as defined in Table 1.1. Additional workforce and MNE control variables as in Table 1.5. Standard errors in parentheses; asterisk marks significance at 1-percent level.

Table 1.8: Separations of Recent Exporter Hires at Unexpectedly Unsuccessful Exporters

	Log[1 + Separations of Recent Exp. Hires]($t+1$)		
	IV	IV×Exp.	
	FE(A)	FE(B)	FE, trend(C)
Predictor (predictors at t not reported)	(1)	(2)	(3)
Unsuccessful Exporters with Pred. Export Indic. above Median			
Pred. Indic. Anticip. Exporter ($t+1$)	4.064	.755	.634
	(1.257)*	(.264)*	(.248)
Observations	576,311	576,218	576,214
$R^2 overall(subsample)$	.257	.256	.257
Unsuccessful Exporters with Pred. Export Indic. above 75th Percentile			
Pred. Indic. Anticip. Exporter ($t+1$)	3.991	.585	.487
	(2.279)	(.287)	(.283)
Observations	257,767	257,623	257,587
$R^2 overall(subsample)$	.260	.262	.261

Sources: SECEX and RAIS 1990 − 2001 (t : 1992 − 2001), manufacturing firms (subsectors IBGE 2 − 13).

Notes: Linear regressions, controlling for firms fixed effects, sector and year effects, and sectoral absorption; for linear sector trends in specification 3. Additional workforce and MNE control variables as in Table 1.5. Standard errors from 50 bootstraps over both stages in parentheses; asterisk marks significance at 1-percent level.

Table 1.9: Predictions of Future Exporter Performance

Predictor (t unless noted)	Log # Destinations($t+1$)			Log Exports/Dest($t+1$)		
	(1)	(2)	(3)	(4)	(5)	(6)
Log # Destinations($t+1$)				.114	.114	.104
				(.012)*	(.012)*	(.012)*
Log Exports/Destinations($t+1$)	.029	.029	.026			
	(.003)*	(.003)*	(.003)*			
Log Employment	.204	.198	.186	.275	.276	.261
	(.008)*	(.008)*	(.008)*	(.016)*	(.016)*	(.017)*
Rel. Empl. Chg.($t-1totpert$)	-.001	-.001	-.001	-.002	-.002	-.002
	(.0008)*	(.0008)*	(.0008)*	(.001)*	(.001)*	(.001)*
Indic. Hires from Exporters	-.010			-.002		
	(.008)			(.016)		
Log Gross Hires from Exp.	.009			.039		
	(.004)			(.007)*		
Indic.:Hires from Start Exp.		-.009	.010		.023	.031
		(.006)	(.006)		(.012)	(.012)
Log Gross Hires from Start Exp.		.006	.016		.014	.015
		(.005)	(.005)*		(.009)	(.010)
Indic.:Hires from Cont. Exp.		.007	-.001		.010	.010
		(.007)	(.010)		(.014)	(.020)
Log Gross Hires from Cont. Exp.		.011	-.003		.029	.007
		(.004)*	(.005)*		(.008)*	(.009)
Indic.:Skld. Bl. Hires fr. Exp.		.	.009			-.034
			(.009)			(.020)
Log Gr. Skld. Bl. Hires fr. Exp.			-.005			.029
			(.004)			(.009)*
Indic.: Mkt. Occ. Hires fr. Exp.		.	-.007			-.008
			(.006)			(.012)
Log Gr. Mkt. Occ. Hires fr. Exp.			.014			-.006
			(.005)*			(.010)
Mean # Overlapping Dest.			.048			.026
			(.002)*			(.003)*
Indic.: High-skill firm	.022	.023	.016	.004	.004	.004
	(.010)	(.010)	(.010)	(.021)	(.021)	(.021)
Indic.: High-skill frm. × Ind.: Hires fr. Exp.			-.070			-.044
			(.010)*			(.022)
Observations	56,141	56,141	56,141	56,141	56,141	56,141
$R^2(within)$	.042	.042	.060	.034	.034	.036

Sources: SECEX and RAIS $1990-2001$ ($t: 1992-2001$), manufacturing firms (subsectors IBGE $2-13$).

Notes: Linear regressions, controlling for firms fixed effects, sector and year effects, and sectoral absorption. Workforces on December 31st. Exports (fob) in thousands of August-1994 USD. Log number of gross hires from exporters set to zero if zero hires. High-skill firms are firms with share of tehnical/supervisory and professional/managerial occupations in top quartile of firm-year observations. Additional workforce and MNE control variables as in Table 1.5. Robust standard errors in parentheses; asterisk marks significance at 1-percent level.

Table 1.10: Predictions of Future Exporter Performance, Controlling for Departing Workers to Exporters

	Log # Destinations$(t+1)$			Log Exports/Dest$(t+1)$		
Predictor (t)	(1)	(2)	(3)	(4)	(5)	(6)
Indic.:Departures to Exporters.	.011	.012	.017	.0008	.002	-.004
	(.006)	(.006)	(.007)	(.013)	(.013)	(.014)
Log Gross Departures to Exp.	.001	-.004	-.008	-.017	-.019	-.023
	(.004)	(.004)	(.004)	(.007)	(.007)	(.007)
Observations	56,141	56,141	44,463	56,141	56,141	44,463
$R^2(within)$	.042	.042	.042			

Sources: SECEX and RAIS $1990-2001$ ($t: 1992-2001$), manufacturing firms (subsectors IBGE $2-13$).

Notes: Linear regressions, controlling for firms fixed effects, sector and year effects, and sectoral absorption. Additional workforce and MNE control variables as in Table 1.9. Robust standard errors in parentheses; asterisk marks significance at 1-percent level.

Appendix

Appendix A: RAIS linked employer-employee information

Brazilian law requires every Brazilian plant to submit detailed annual reports with individual information on its workers and employees to the ministry of labor (*Ministério de Trabalho*, MTE). The collection of the reports is called *Relação Anual de Informações Sociais*, or RAIS, and typically concluded at the parent firm by March for the preceding year of observation. RAIS is a nationwide, comprehensive annual record of workers formally employed in any sector (including the public sector). RAIS covers, by law, all formally employed workers, captures formal-sector migrants, and tracks the workers over time. By design, however, workers with no current formal-sector employment are not in RAIS. The data provides monthly spell information on individually identified workers at individually identified plants. Similar to our treatment of the SECEX data, we aggregate the monthly worker-plant information to years and firms. Annual aggregation removes seasonal fluctuations in worker accession and separation rates from the data.

RAIS primarily provides information to a federal wage supplement program (*Abono Salarial*), by which every worker with formal employment during the calendar year receives the equivalent of a monthly minimum wage. A strong incentive for compliance is that workers' benefits depend on RAIS so that workers follow up on their records. The payment of the worker's annual public wage supplement (*Abono Salarial*) is exclusively based on RAIS records. The ministry of labor estimates that currently 97 percent of all formally employed workers in Brazil are covered in RAIS, and that coverage exceeded 90 percent throughout the 1990s.

We keep observations for the years 1990 through 2001, drop all firms outside manufacturing, and then use the data for the construction of several sets of variables. First, we use employment on December 31st to obtain information on the firm's workforce size and composition across all its plants. We pay attention mainly to the education and occupation categories and construct according shares (see Appendix 1.6 for definitions). Second, we use worker IDs to trace recent hires at potential exporting firms back to their preceding employer and count the number of gross hires who were employed at an exporter in their immediately preceding job. For the purpose of worker tracking, we restrict the worker sample to all proper worker IDs (11-digit *PIS*).

Third, we obtain industry information for every firm. RAIS reports industries at the subsector IBGE classification (roughly comparable to the *NAICS 2007* three-digit level) over the full sample period. Subsector IBGE industries are recorded by plant, however. There are multi-plant firms in our sample, and we assign the industry associated with most employees in a given year to multi-plant firms. At the subsector IBGE level, there are twelve manufacturing industries in RAIS. The main sector affiliation of firms varies over time. There are 36,599 observations of firms that change sector so that firm effects are not nested within sector effects in later empirical analysis. While RAIS offers comprehensive workforce information, data on domestic sales are neither available from SECEX nor RAIS.

Table Appendix A 1.1: Firm Characteristics by Industry

Subsector IBGE	Firm-year observ.	Workers per firm	Share(%) exporters	Workers per exp.	Exports per exp.
Non-metallic mineral products	137,091	18.8	.026	212.5	1,574.7
Metallic products	201,093	24.8	.046	288.4	5,974.8
Machinery, equipment and instruments	73,976	39.4	.152	167.9	1,962.3
Electrical and telecomm, equipment	40,603	51.9	.123	285.8	2,618.3
Transport Equipment	39,169	80.9	.103	622.4	13,010.7
Wood products and furniture	234,913	15.2	.042	120.1	1,064.9
Paper and paperboard, and publishing	132,108	23.0	.023	349.9	5,118.3
Rubber, tobacco, leather, and prod. nec.	96,152	25.3	.082	173.1	2,805.6
Chemical and pharmaceutical products	131,110	37.2	.099	206.4	2,100.9
Apparel and textiles	332,926	20.6	.025	314.1	1,290.1
Footwear	48,881	46.5	.099	206.4	2,100.9
Food, beverages and ethyl alcohol	299,469	34.1	.024	637.2	9,372.6
Total	1,767,491	27.7	.049	278.9	3,598.7

Sources: SECEX and RAIS 1990 – 2001 (t : 1992 – 2001), manufacturing firms (subsectors IBGE 2 – 13).

Notes: Employment on December 31st. Exports (fob) in thousands of August-1994 USD.

Table 1.1 reports firm counts, the share of exporters (from the link to SECEX exporter information) and select firm characteristics by subsector IBGE. On average, only about 5 percent of Brazilian formal-sector manufacturing firms are exporters, a considerably smaller share than in Chile, where 21 percent of manufacturing plants are exporters in 1990-96 (Alvarez and López(2005)), or Colombia (18 percent of plants in 1991 Brooks(2006)), Mexico (36 percent of plants in 1996,Iacovone and Javorcik(2012)) or the United States (18 percent of firms in 2002 Bernard, Jensen, Redding, and Schott(2007)). Exporting is most frequent in machinery and equipment manufacturing industries, where workforce sizes per firm also tend to be large. Except for transportation equipment, the industries with most frequent exporting are populated by firms with below-average sizes and below-average exports per firm. We will account for sector differences with industry-fixed effects in all later regressions.

Appendix B: SECEX exports data

All export values in the SECEX exports data are reported in current U.S. dollars (USD), free on board (fob). We have observations on exporting plants, declared export values and export destinations for the years 1990 through 2001. We aggregate monthly plant-level export information to years and firms. As mentioned in the text, we deflate export sales to their August-1994 equivalents using the monthly U.S. consumer price index (from Global Financial Data). Table 1.1 reports firm counts, exporter shares and select firm characteristics by subsector IBGE.[26]

Table Appendix B 1.1: Summary Statistics

	All firms		Exporters		Export Status (t)		
					Continuous	Start	Quit
Variable	(1)		(2)		(3)	(4)	(5)
Foreign-market participation							
Indic.: Exporter(t)	.049		1.000		1.000	1.000	
Indic.: Affiliate of foreign MNE(t)	.0001		.0005		.0007	.0002	.0002
Log # Destinations(t)	.986		.986		1.375		.376
Log Exports/Destination(t)	3.832	3.832		4.423		2.906	
Anticip. Continuous Exporting($t+1$)	.031	.619		.854		.252	
Anticip. Start Exporting($t+1$)	.017		.136			.350	.192
Anticip. Quit Exporting($t+1$)	.013		.163		.076	.298	.398
Anticip. Non-exporter for three years($t+1$)	.741						.287
Size							
Employment(t)	28.2		285.4		386.1	127.9	87.2
Net Employment Change ($t-1$to$t$)	-.2		-5.5		-13.0	7.2	-6.1
Workforce characteristics							
Share: Unskilled blue-collar occupation(t)	.130		.127		.120	.137	.132
Share: Skilled blue-collar occupation(t)	.631		.576		.573	.580	.560
Share: White-collar occupation(t)	.239		.297		.306	.283	.309
Share: Primary school education(t)	.756		.673		.662	.690	.690
Share: High school education(t)	.207		.232		.234	.229	.228
Share: Tertiary education(t)	.037		.095		.104	.081	.081
Workforce background							
Indic.: Hires from Exporters(in$t$)	.205		.741		.786	.671	.529
Gross Hires from Exporters(in$t$)	1.1		12.1		15.2	7.3	3.5

Sources: SECEX and RAIS $1990-2001$ ($t: 1992-2001$), manufacturing firms (subsectors IBGE $2-13$).

Notes: $1,557,474$ regression sample observations (employment change based on $1,277,201$ observations of frims with consecutive-year presence). export status as defined in Table 1.1. Current exporters (column 2) include firms with continuous exporting (column 3) or that start exporting (column 4) but not firms that recently quit exporting (column 5). Workforce on December 31st. Exports (fob) and annualized December wages in in thousands of August-1994 USD.

[26] We consider as industrialized countries the 24 OECD member countries in 1990: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal (including Madeira Islands), Spain (including Alborán, Parsley Island, and Canary Islands), Switzerland, Turkey, United Kingdom (including Channel Islands), and the United States. We exclude the following types of exports and destinations: immediate reexports of imports, on-board aircraft consumption, and non-declared destinations.

Table 1.1 summarizes variables for the universe of manufacturing firms, restricting the sample to 1992-2000 to account for one lead in addition to two lags in export status. There are substantive differences in export-market participation among exporters. Compared to firms that start exporting, continuous exporters serve 2.7 times (one log unit) more destinations and have 4.6 times (one-and-a-half log units) larger sales per destination. Continuous exporters have only a one-in-twelve chance to quit exporting, while firms that recently started exporting (within the past two years) quit exporting with a one-in-three chance.

Exporting is transitory for most Brazilian exporters. Similar to evidence in Brooks (2006) for Colombian plants between 1981 and 1991, only a fraction of any cohort of first-time exporters continues to export after a year. Of the 1993 cohort, for instance, less than a quarter of firms is still an exporter by 1998, five years later. Of the 1996 cohort, only slightly more than a quarter of firms is still an exporter by 2001.[27]

Appendix C: Education and occupation categories in RAIS

We group education information from nine RAIS education categories into three categories as shown in Table 1.1.

Table Appendix C 1.1: EDUCATION CATEGORIES

	RAIS category	Education Level
1.	8.-9.	Some College or College Graduate
2.	6.-7.	Some High School or High School Graduate
3.	1.-5.	Illiterate, or Primary or Middle School Educated (*reference category*)

Occupation indicators derive from the 3-digit CBO classification codes in our nationwide RAIS data base, and are reclassified to conform to ISCO-88.[28] We map RAIS occupations into ISCO-88 categories and regroup them into five categories as shown in Table 1.2.

[27] An empirical supplement with according tabulations is available at URL *econ.ucsd.edu/muendler*.

[28] See online documentation at URL *econ.ucsd.edu/muendler/brazil*.

Table Appendix C 1.2: Occupation Categories

	ISCO-88 occupation category	Occupation Level
1.	Legislators, senior officials, and managers	Professional or Managerial
	Professionals	Professional or Managerial
2.	Technicians and associate professionals	Technical or Supervisory
3.	Clerks	Other White Collar
	Service workers and sales workers	Other White Collar
4.	Skilled agricultural and fishery workers	Skilled Blue Collar
	Craft and related workers	Skilled Blue Collar
	Plant and machine operators and assemblers	Skilled Blue Collar
5.	Elementary occupations	Unskilled Blue Collar (*reference category*)

Earnings. For descriptive purposes, we use the monthly December wage paid to workers with employment on December 31st of a given year. RAIS reports the December wage in multiples of the current minimum wage. We use the log of annualized December wages as our earnings measure, defined as the reported monthly wage times the December U.S. dollar equivalent of the current minimum wage times 12. Similar to export values, we deflate this earning measure to its August-1994 equivalent using the monthly U.S. consumer price index (from Global Financial Data).

Sector and legal form. Sector information for the firm is not available from the exporter data (SECEX), which only reports exported products, so we extract a firm's industry from RAIS. We use the annual mode of subsector IBGE across the firms' workers because, within the firms, plants can operate in different sectors. Subsector IBGE information is reported for the full sample period, whereas finer industry categories only become available in later years.

RAIS also reports a firm's legal form, including its direct foreign ownership by a foreign company (the according legal form code is "branch or office of foreign company"). Indirect foreign ownership, minority foreign ownership, or portfolio holdings do not fall under this category. We use the annual mode of legal form across the firms' workers to deal with occasional coding errors of legal form. The self-reported foreign-ownership category in RAIS potentially differs from foreign ownership in Poole (2012), who uses independent information on direct and indirect foreign ownership from the Central Bank of Brazil for a shorter sample period.

Chapter 2

Financing Constraints

Abstract

Using detailed Colombian firm-level data, this paper investigates the influence of financing constraints on export growth. My results suggest that firms with higher debt balances export less and grow at lower rates, especially during periods of economic distress. My newly constructed data set decomposes firms' liabilities by source of financing, term of financing and currency composition. I use this data to provide evidence that financing constraints affect firms' extensive and intensive margins of exports. However, only a subset of financing constraints are related to exports. I show that short-term debt with domestic banking institutions is negatively related to a firm's extensive and intensive margins of trade, while supplier trade debt has a positive effect on a firm's intensive margin of exports. I show that firms located in sectors with higher dependence on external financing exhibit higher growth in their intensive margins of exports. During periods of economic distress, I find that credit constrained firms are more affected by a short supply in credit. Surprisingly, firms in more vulnerable industries seem to be less affected by economic downturns.

Keywords: International trade; External financing constraints.

JEL Classification: F12.

2.1 Introduction

Firms use internal and external sources of financing to cover the upfront costs that are usually due before production and sales can are realized. In this sense, domestic and exporting firms are not very different from one another, as they both require working capital to pay for upfront costs. However, exporters accrue additional upfront costs in their efforts to service foreign market destinations. In contrast to domestic production, the overall magnitude of additional upfront costs required to export makes production to foreign market destinations more dependent on external sources of funding.

For this paper, I have constructed a novel data set using detailed firm level information regarding exports and the liability composition of Colombian firms. Following the theoretical results of Chaney (2005) and Manova (2010), I provide empirical evidence of the negative relationship between a firm's future export growth and a firm's current credit constraints. Conceptually, I determine whether a firm is credit constrained by measuring its ratio of total liabilities to total assets. Lenders infer that firms with high leverage ratios have a lower probability of loan repayment. Consequently, such firms become credit constrained, as lenders decrease the amount of lending they are willing to supply when they fear that firms will not be able to repay their loans.[1]

I then decompose firms' sources of external financing into the following sub-accounts: supplier trade debt, accounts payable,[2] debt with banking institutions, corporate bond debt and other liabilities. Supplier trade debt is decomposed by currency denomination of debt: domestic and foreign.[3] Debt with banking insti-

[1]Muûls (2008) identifies whether a firm is currently credit constrained by using a credit index that measures the credit reliability of Belgian firms. As the author explains, the index is constructed with information related to the previous credit history of the firm. Leverage and liquidity ratios are reported to be two of the dimensions that are taken into account to construct the index.

[2]Supplier trade debt refers only to transactions between a firm and its suppliers (domestic or foreign) that imply the transfer of goods-services without immediate payment funds. By Colombian accounting standards, this sub-account is by definition a short-term account. Accounts Payable refers to the following liabilities pending of immediate payment: debt with stockholders, debt with workers, retained value added tax, retained industry tax and retained taxes on wages.

[3]I use foreign to refer to any liability denominated in any other currency besides the Colombian peso. The original data source reports liabilities in foreign currency in US dollars.

tutions is decomposed between short and long-term debt,[4] and within each term I disaggregate debt by currency denomination.

I use this disaggregation to provide evidence that only a subset of external sources of financing are related to firms' extensive and intensive margins of exports. In particular, I find that a firm's extensive and intensive margins of exports are negatively related to short term debt obtained from domestic banking institutions. My results suggest that supplier trade debt may have an indirect positive correlation with export performance through the number of destinations and the number of products that a firm exports.

Previous literature on growth and financial development provides evidence that sectors with significant dependence on external sources of financing exhibit higher growth rates when located in financially developed economies (Rajan and Zingales (1998)). Instead of linking differences in sectoral growth rates to differences in the development of financial institutions across countries, I focus in one country (Colombia), and I show that firms in financially dependent sectors[5] exhibit higher growth rates in the intensive margin of exports when relying on short term debt provided by banking institutions.

My data set is constructed using Colombian data from 1995 through 2006. This time period is characterized by an exchange rate crisis in 1998 and a financial crisis in 1999. These crises stemmed from a domestic recession, intensified by the 1997 Asian crisis. As reported in figure 2.1(a), Colombian GDP contracted almost 4.5% in 1999, exports collapsed by 9% between 1997 and 1999 (see figure 2.1(b)), and credit provided by banking institutions to the private sector (measured as ratio to GDP) decreased from 45% in 1997 to 17% in 2000 (see figure 2.2(a)).[6] Even though demand recovered by year 2000, private credit provided by banking institutions remained constrained through 2003. I therefore test whether, during the crisis period, firms relying on external sources of financing were more affected

[4]Following accounting standards, short-term refers to liabilities due within a year. Long-term refers to liabilities due in more than one year.

[5]As is the benchmark procedure in this literature, I use Rajan and Zingales's (1998) external financial dependence variable of young firms, to determine the sectoral external financing needs.

[6]Villar and Rincon (2001) provide a detailed description of the adjustment experienced by the Colombian economy during the 1990's.

by the limited availability of credit between 1998 and 1999. My estimates suggest that during the crisis period, exporters' intensive and extensive margins of trade were negatively affected by this credit crunch. Surprisingly, firms in financially dependent sectors were less affected by the credit shock.

Additionally, within this period the Colombian peso experienced a depreciation phase that lasted until 2003 (see figure 2.2(b)). I am thus able to test whether entry and export performance are negatively affected by the depreciation of the Colombian peso through a balance sheet effect on foreign supplier trade debt and debt with foreign banking institutions (Bleakley and Cowan (2009)). I do not find any evidence of a balance sheet effect on firms' extensive and intensive margins of exports.[7]

My empirical strategy is to relate firms' intensive and extensive margins of exports to their sources of external financing, which I assume to be given. My empirical estimation relies on the fact that firms use external sources of financing differently depending on sector and year. While some firms may primarily use debt with banking institutions to finance cash flow needs, others may use supplier trade debt as their main source of external financing. In all specifications I control for firms' growth rate of domestic sales, tangible assets, supply shock and two sets of fixed effects: sector and year. Controlling for the growth rate of sales in the domestic market eliminates non-observable, firm specific factors that might affect both export growth and a firm's debt choice. This enables me to relate future export growth in a firm's extensive and intensive margins of exports with the firm's sources of external credit constraints.

Since firms use tangible assets as collateral to ease access to external financing, in all specifications I control for a firm's tangible assets. As in Iacovone and Zavacka (2009), I introduce a firm-specific exchange rate index to control for supply shocks affecting a firm's volume of exports.[8] The use of industry and year

[7]In a structural model applied to Colombian exporters, Das, Roberts, and Tybout (2007) recuperates fixed cost of exporting, and provides evidence of the effect of an exchange depreciation on sales and profits. This model was calibrated for a subset of manufacturing firms for a sample period characterized by a fixed exchange rate regime. In these years, the Colombian economy was following a protectionist model which was subject to a complete reform executed in 1991.

[8]Appendix B: Definition of Variables provides a complete description of this variable.

fixed effects controls for sectoral and macro shocks affecting both exports and access to external sources of financing. This ensures that my specification is only relating external sources of credit constraint to a firm's export margins.

My findings contribute to and build upon a wealth of literature in this field. The notion that there are real effects of external financing on growth has been previously well documented in the literature of financial development and growth. In a seminal contribution, Rajan and Zingales (1998) provide evidence suggesting that countries with more developed financial systems have a comparative advantage in sectors with higher dependence on external sources of funding. Similarly, Petersen (1997) and Fisman and Love (2003) suggest that in less financially developed countries, external financing to the firm may be obtained from different sources. Following Rajan and Zingales's (1998) setup, these authors suggest that countries with less developed financial systems have a comparative advantage in sectors with higher dependence on external sources of funding when external financing is provided in the form of supplier trade debt. These papers provide a clear link between external financing and growth, with the common assumption that external financing needs are determined by an industry's technological characteristics.

Related to the literature measuring real effects of banking and financial crises on sectoral growth, Braun and Larrain (2005), Kroszner, Laeven, and Klingebiel (2007) and Dell'Ariccia, G., Detragiache and Rajan (2008) use cross-country sectoral data to provide evidence of the negative relationship between growth and financial crises. As these authors discuss, during periods of economic distress sectors with higher dependence on external financing exhibit the highest reductions in growth rates. A common problem within this literature is that estimates do not address the endogeneity problem between crises and growth.[9]

Amiti and Weinstein (2009) subsequently used detailed bank-firm information from Japan to establish a causal link between the health of banking institutions providing trade financing to a firm, and the firm's export growth.[10]

[9] Lower growth rates may deter the ability of agents to repay back loans, so crises may arise as a consequence of low growth rates.

[10] Amiti and Weinstein (2009) define trade financing as either credit, insurance or guarantees

My paper is most closely tied to the emerging literature on credit constraints and international trade. Chaney (2005), Muûls (2008) and Bellone, Musso, Nesta, and Schiavo (2009) suggest that a firm's external financing only affects a firm's ability to enter foreign export markets.[11] Manova (2010) extends Melitz's (2003) setup by including the net bank expected profits as a constraint within the optimal decision problem of the firm. Furthermore, she allows firms to use external financing to finance both fixed and variable costs of production. As a result, external financing affects exporters not only through the extensive margin as in Chaney (2005), but also through the intensive margin of trade. Furthermore, consistent with previous literature in Industrial Organization,[12] firms with higher external financing exhibit less competitive prices.[13] Although these papers help us to understand how external financing may affect a firm's decision to export or adjust its intensive margin of trade in tranquil times, neither paper addresses that firms export performance may be affected differently depending on which sources of external financing they rely upon.

Finally, my paper is also connected to the literature of firm performance and balance sheet effects. In the period covered by my data, the Colombian real exchange rate experienced a sharp depreciation. According to the J-Curve literature, this should imply an increase in firm export volume, since goods became less expensive for foreign markets. However, this "competitive" effect of a depreciation can be off-set if a firm has strong exposure to liabilities in foreign currency (See Bleakley and Cowan (2009), Echeverry, Fergusson, Steiner, and Aguilar (2003) and Berman and Berthou (2006)).

My findings expand upon this literature in the following ways: First, this is one of only a few papers to provide evidence of the relation between margins of export and external credit constraints using firm level data. Second, I show

issued by a bank or other financial institution to facilitate trade.

[11]Chaney (2005) and Muûls (2008) introduce external financing of a firm by a liquidity draw which is assume to be i.i.d from the productivity heterogenous draw.

[12]Showalter(1995, 1999) provides a complete characterization of an oligopolistic competitive model, where firms chose optimal prices and optimal debt loads with uncertain demand.

[13]Conditional on the productivity level of the firm, higher reliance on external financing implies lower sales. In this model, sales are indirectly negatively affected by external financing through prices.

that only a few sources of external financing are related to margins of exporting. Third, my findings illustrate that firms located in sectors with higher dependence on external financing exhibit higher growth in their intensive margin of exports. Finally, I show that during periods of economic distress, credit constrained firms are more affected by the short supply in credit. Surprisingly, firms in more vulnerable industries seem to be less affected by the economic downturn.

Even though my empirical estimation controls for firm-specific factors affecting both access to financing and export performance, my results are limited in the sense that I cannot give causal interpretations between credit choice and future export growth. I base my interpretations on the assumption that a firm's leverage ratio can be used to infer how credit constrained the firm is, and I use the liability decomposition to identify the specific sources of credit that are related to future export growth.

This paper is structured as follows: section 2.2 summarizes why external financing to firms is more important for exporting firms, and also describes the theoretical results embodied by previous models of international trade and firm credit constraints. Section 2.3 describes my data set. Section 2.4 formulates the empirical estimation strategy and discusses my results; and finally, section 2.5 concludes.

2.2 External Financing and Related Literature

2.2.1 Relevance of External Financing

Production is a capital intensive activity that requires the payment of upfront costs which are generally financed by a firm's internal and external resources. External resources are usually used when a firm cannot pay the entire upfront costs of production with internal resources. In this case, access to external financing becomes an important instrument that enables a firm to overcome cash flow needs without affecting its scale of production. In this sense, domestic and exporting firms are not very different from each other, as they both require working capital to cover upfront costs.

In comparison to domestic firms, exporters accrue additional upfront costs. Some of these costs are related to the fixed costs of exporting, affecting entry into export market destinations, while others are related to an increase in the marginal cost of production. The latter can be explained in part by additional per unit transportational fees implied by shipping goods to foreign market destinations, or because unit costs increase as firms decide to upgrade product characteristics to match consumer preferences in foreign market destinations. Either way, an increase in the variable cost structure of the firm affects a firm's optimal pricing rule, a firm's optimal revenue and consequently a firm's optimal profit.

In addition to paying additional upfront costs, exporters also face a cash flow mismatch between the time when costs are accrued and the time when revenue from foreign market destinations is realized. Along these lines, Djankov, Freund, and Pham (2006) provide evidence of the additional time it takes exporting firms to ship goods internationally. On average it takes 31 days for firms to transport a 20 foot container from its factory doors into a shipping vessel, and another 25 days for firms in the destination country to receive the good at the purchaser's location.

Because final payment for exported goods is only realized once goods have been physically delivered to a foreign purchaser, exporters need to finance operational costs for at least two additional months beyond what is required by domestic producers. Exporters are thus more dependant on external sources of financing than domestic producers.

Understanding how exporters rely on external sources of financing allows us to determine how credit constraints impact firms' future export growth, especially during periods of economic distress. Several recent papers on trade and financing constraints provide evidence of the real effects of external financing on firms' export volume. In the following sub-section I will provide a brief overview of the results obtained by applying Melitz's (2003) model of trade when exporters face credit constraints (Manova (2010)).

2.2.2 Theoretical Related Framework

Recent literature on international trade has accounted for the effects of credit constraints on export market entry and firms' intensive margins of trade. In this section, I will use Manova's (2010) model to highlight the effects of credit constraints on a firm's decision to export and on a firm's intensive margin of exports. I will then use these findings to guide my empirical estimation in section 2.4.

Under Manova's model, exporters can finance production costs with either internal or external resources. When firms lack sufficient internal resources to finance their total costs of production, they require external financing to cover their remaining costs. In this case, firms acquire external financing from financial markets by pledging tangible assets. With a given probability of success, capital constrained firms agree to pay to lenders a return on the lent capital. In the case of default, a firm is obliged to honored the contract with the collateral used to secure the loan.

As in Melitz (2003), firms self-select into exporting when their productivity is above a certain cut-off level. However, financially dependant firms generally experience a higher productivity cut-off condition. Under this setup, a firm's decision to export will depend on how dependant the firms is on external sources of financing. The higher is a firm's dependance on external financing, the higher the threshold will be; making entry into exporting only possible for highly productive firms. Furthermore, only high productive firms can secure external financing by offering high returns to creditors. This guarantees them access to the external financing they will need to avoid the shrinkage in production scale that would otherwise occur when external financing is constrained. Across sectors, entry into exporting becomes more difficult as sectoral characteristics induce firms to become more dependant upon external sources of financing.

Conditional on their level of productivity, firms relying on external financing are induced to price their products less competitively, implying a lower volume of trade. Firms that are more dependent on external financing are consequently expected to exhibit a lower volume of exports.

Credit constraints also affect the number of destination countries a firm chooses to serve and the number of products that a firm decides to trade. In terms of destinations, financially constrained firms will choose to service destinations by ranking them from most profitable to least profitable. Conditional on the external financing obtained by the firm, the number of destination markets it serves is directly related to how credit constrained the firm is. Constrained firms will be able to export to fewer destinations. Likewise, firms facing external financing constraints will export only the most profitable products, and will ship fewer products to their foreign market destinations.

External financing to the firm can be obtained from alternative sources. As suggested by Fisman and Love (2003), in non-developed economies firms rely on external sources of financing that ease financing constraints imposed by banking institutions, such as supplier trade debt. In these economies, sectors relying heavily on alternative sources of financing perform better in terms of growth and sales as compared to firms who cannot access such financing.[14]

To summarize, credit constraints affect both a firm's extensive and the intensive margin of trade (through number of countries, and number of products). These effects are more pronounced when firms are more dependant on external sources of financing. Understanding how a firm uses external sources of financing allows us to identify the financing sources that might be used to lessen the adverse effects of external financing on a firm's extensive and intensive margins of trade.

2.3 Data

To relate a firm's extensive and intensive margin of exports to its external sources of financing, I construct an unbalanced panel dataset using detailed information on exports and financial statements of Colombian firms for the period 1995-2006. I restrict the sample to firms classified within the industrial sectors of Agriculture (sectors 1-5) and Manufacturing (sectors 15-39) as defined by the international standard industry classification, ISIC revision 3.1. I exclude obser-

[14]Petersen (1997) provide a complete characterization of the different theories explaining why relying on supplier trade debt might be beneficial for firms.

vations with total assets, sales and tangible assets reported as zero or negative. The dataset is composed of 9,823 firms, of which 5,028 exported at least once and 4,795 only produce for the domestic market.

Firm export information was obtained from the Transaction Export Dataset (TED) processed by "Dirección de Impuestos y Aduanas Nacionales" (DIAN). As explained by Eaton, Eslava, Kugler, and Tybout (2007, 2008), TED contains the universe of transactions realized by Colombian exporters at the product level[15] per destination country. From this dataset I extracted annual information related to volume of exports (intensive margin), total number of export destinations and total number of products exported.

Financial information is extracted from the Financial Statement dataset processed by "Superintendencia de Sociedades" (SS). Colombian regulations establish that at the end of every fiscal year[16] commercial firms should report their financial statements to SS when assets or total sales are above a minimum threshold. In 2006, this threshold was set at approximately 5.18 million U.S. dollars.[17]

From SS I obtained annual information related to Colombian firms' total sales, total domestic sales, tangible assets, total assets and total liabilities. I disaggregate firms' total liabilities within the following five types of external financing: supplier trade debt, accounts payable, debt with banking institutions, corporate bond debt and other liabilities. I separate supplier trade debt from the aggregate measure of accounts payable. When using the aggregate measure of accounts payable,[18] estimates capture the effect of other balance sheet accounts not related to obtaining credit from suppliers. Consequently, in this paper supplier trade debt[19] refers only to transactions between a firm and its suppliers (domestic or

[15]Defined at the 10 digit level of the harmonized system code.

[16]Decree 2649 of 1993 determined that fiscal years in Colombia are set on December 31st.

[17]As explained in Appendix A: Regulation and Firm Inclusion Criteria - SS dataset, the threshold is usually set as a multiple of the minimum Colombian monthly wage. Furthermore, and as explained in the appendix, legislation has modified the minimum threshold on three different occasions.

[18]As in, Petersen (1997) and Fisman and Love (2003)).

[19]By construction, supplier trade debt is classified as a short term debt.

foreign) that imply the transfer of goods or services without immediate payment of funds. Accounts payable refers to the following liabilities pending immediate payment: debt with stockholders, debt with workers, retained value added tax, retained industry tax and retained taxes on wages.

I decompose debt with banking institutions between short and long-term debt. Short-term refers to liabilities due within one year, and long-term refers to liabilities due in more than one year. I disaggregate both short and long-term debt with banking institutions by currency denomination of debt.

This thorough liability decomposition is what I refer to throughout the paper as a firm's sources of external financing. I use this decomposition to relate firms' sources of external financing with their respective margins of trade.

I obtained data on exchange rates from the World Bank's World Development Indicators (WDI). Producer price indexes were obtained from several sources depending on sectoral availability per country. For the US, I obtained this information from the Bureau of Labor Statistics. For Ecuador and Venezuela, I obtained this information directly from the series reported by the corresponding Central Banks. For all other countries I use the aggregate index available in WDI.

2.4 Empirical Strategy and Results

2.4.1 Empirical Strategy

As discussed in sub-section 2.2.2, firms relying more on external financing enter into fewer foreign market destinations, export less, and reduce their product scope by exporting only the most profitable products. If entry and the intensive margin of exports are affected by a firm's dependence on external financing, one should expect to observe a negative relationship between a firm's export margins and its external financing dependance, which I measure with the leverage ratio.[20] My estimation strategy uses the variance of firms' dependance on external financ-

[20] As in Greenaway, Guariglia, and Kneller (2007) I use the leverage ratio to determine how financially dependant a firm is on external financing.

ing across sectors to provide evidence of the negative relationship between a firm's export growth and its sources of external financing. Since a firm's export performance is related to additional factors besides leverage, in all of my specifications I control for firms' growth of domestic sales, asset tangibility ratio, supply shock and two sets of fixed effects: sector and year. My baseline specification is given as follows:

$$\begin{aligned} \triangle \mathrm{y}_{i,t+1} =& \gamma \mathrm{leverage}_{i,t} + \beta_1 \Delta \mathrm{salesdom}_{i,t+1} + \beta_2 \mathrm{tang}_{i,t} + \\ & \beta_3 \mathrm{eshock}_{i,t+1} + \vec{\Theta}\vec{D}_s + \vec{\mu}\vec{D}_t + \varepsilon_{i,t} \end{aligned} \tag{2.1}$$

Subindex i identifies the firm, subindex t identifies the period, and subindex s is a sector indicator. Firms are clustered in 178 industrial sectors defined at the four digit level of disaggregation of the ISIC revision 3.1 industrial classification.

$\triangle \mathrm{y}_{i,t+1}$ corresponds to the difference between t+1 and t of any of the following four dependant variables: Extensive Margin, Intensive Margin, Number of foreign Destinations and Number of Products Exported. The Extensive margin is an indicator variable that operates as follows: it takes the value of 1 when a firm only exports in t+1; 0 when it exports in both t+1 and t; and -1 when a firm only exports in period t. The intensive margin is measured by the difference in logarithms of a firm's export volume between t+1 and t. The number of foreign destinations and number of exported products correspond to the difference between t+1 and t of the overall number of countries that a firm exports to, and the overall number of products that a firm exports. It is important to clarify that differences in the intensive margin, the number of countries and the number of products are all taken into account when a firm exports in both t+1 and t.

As provided in equation 2.1, besides a firm's leverage ratio ($\mathrm{leverage}_{i,t}$), I control for additional factors that might relate to a firm's export performance or to a firm's access to external financing. For example, I control for foreign demand, exchange rates (supply shock) and factor endowments. $\Delta \mathrm{salesdom}_{i,t+1}$ is the difference in logarithms of domestic sales in periods t+1 and t, and it controls for non-observable firm-specific factors that might be correlated with both export performance and leverage choice. Similar to Beck (2003) and Manova (2010),

$\text{tang}_{i,t}$ controls for the hardness of assets of the firm (tangible assets). $\text{eshock}_{i,t+1}$ is firm-specific supply shock measured as the weighted sum of the differences in logarithms of the bilateral real exchange rate of a firm's export market destinations.[21] As a weight I use the relative importance of the destination market within the firm's total volume of exports in period t. Assuming that omitted factors relate to export performance and that a firm's external financing choices are common to all exporters within an industry at a moment in time, in all specifications I include sector and year fixed effects to reduce the bias in my estimates.

Given that sectoral technological characteristics determine a firm's need to rely on external financing (See, Beck (2002), Manova (2010)) and that my sample is characterized by a period of crisis, I extend my baseline specification in three directions. First, I test whether firms in externally financially dependant industries exhibit higher export growth rates. I use Rajan and Zingales's (1998) external financial dependance sectoral measure to test whether firms in industries with substantial dependence on external financing exhibit higher growth rates on export margins.[22] Given that my estimates include sector fixed effect, I interacted Rajan and Zingales's (1998) external dependance sectoral measure with a firm's external sources of financing. Therefore, my baseline specification is modified as follows:

$$\begin{aligned} \triangle \text{y}_{i,t+1} =& \vec{\gamma}\text{leverage}_{i,t} + \vec{\lambda}\text{leverage}_{i,t} \times \text{extdep}_s + \beta_1 \Delta\text{salesdom}_{i,t+1} + \\ & \beta_2\text{tang}_{i,t} + \beta_3\text{eshock}_{i,t+1} + \vec{\Theta}\vec{D}_s + \vec{\mu}\vec{D}_t + \varepsilon_{i,t} \end{aligned} \tag{2.2}$$

$\vec{\gamma}$ and $\vec{\lambda}$ represent the coefficients related to the sources of external financing of a firm, and the interaction between Rajan and Zingales' external financial sectoral dependance measure and a firm's sources of external financing. I focus my attention on the significance of the interaction terms ($\vec{\lambda}$).

Second, I test whether during the crisis period (1998 and 1999), firms relying on external sources of financing were more affected by the limited availability

[21] Appendix 2.5 provides a complete description of this variable.

[22] In particular, I use Rajan and Zingales's (1998) external dependance sectoral measure for young firms.

of credit. My estimates extend the baseline specification in equation 2.1 by introducing a triple interaction between each source of external financing, a crisis period dummy[23] and Rajan and Zingales's (1998) measure of external financial dependance.[24] Estimates are extended as follows:[25]

$$\begin{aligned}\triangle \mathrm{y}_{i,t+1} =& \vec{\gamma}\mathrm{leverage}_{i,t} + \vec{\lambda_1}\mathrm{leverage}_{i,t} \times \mathrm{extdep}_s \times \mathrm{crisis}+ \\ & \vec{\lambda_2}\mathrm{leverage}_{i,t} \times \mathrm{extdep}_s + \vec{\lambda_3}\mathrm{leverage}_{i,t} \times \mathrm{crisis}+ \\ & \lambda_4 \mathrm{extdep}_s \times \mathrm{crisis} + \beta_1 \Delta \mathrm{salesdom}_{i,t+1}+ \\ & \beta_2 \mathrm{tang}_{i,t} + \beta_3 \mathrm{eshock}_{i,t+1} + \vec{\Theta}\vec{D}_s + \vec{\mu}\vec{D}_t + \varepsilon_{i,t}\end{aligned} \tag{2.3}$$

Estimates on $\vec{\lambda_1}$, $\vec{\lambda_3}$ and λ_4 will provided evidence of the effect of the crisis period on export margins per source of external financing.

Third, given that the Colombian peso depreciated between 1998 and 2003, I test whether exporters were negatively affected by depreciation of the Colombian peso through a balance sheet effect on debt denominated in foreign currency.

My results will be presented in the following order: First, I discuss the results associated with my baseline specification (equation 2.1). Second, I disaggregate a firm's external financing by sources. Third, I provide evidence of the difference in export growth rates when firms are classified in industries that are heavily dependent on external financing. Fourth, I provide evidence off the real effect of the credit crunch on firms' margins of export. Fifth, I test whether exporters were adversely affected by the depreciation of the Colombian peso.

2.4.2 Results

Table 2.2 provides the results obtained when I estimate equation 2.1. Column 1 reports the estimates for my measure of extensive margin if exports. Column

[23]Defined as a dummy variable taking the value of one in years 1998 and 1999, zero otherwise.

[24]Estimates include the following additional interaction terms: Sources of external financing $\times$ the crisis period, the crisis period $\times$ Rajan and Zingales's (1998) external financial dependance measure and Sources of external financing $\times$ Rajan and Zingales's (1998) external financial dependance measure.

[25]Rajan and Zingales's (1998) external financial dependance measure and the crisis dummy are excluded from this specification since they capture both the sector and year fixed effects $(D_s and D_t)$.

2 reports estimates for the intensive margin of exports, column 3 reports estimates on the intensive margin through the number of destinations a firm exports to, and columns 4-5 report results on the intensive margin through number of products exported by the firm. Products are defined at the 10 and the 6 digit level of disaggregation of the harmonized system code (HS).[26]

My results suggest that the depreciation of the real exchange rate has a positive impact on firms' intensive margins of trade. Exporting firms seem to export more per destination, and although not significant, the effect seems to be related to an increase in the total number of products exported.

As in Chaney (2005) and Muûls (2008), leverage seems to only affect exporters through their extensive margins of trade. Highly leverage firms are less likely to export to foreign market destinations in the future, as the threshold that determines entry into exporting markets is higher for more leveraged firms.

Given that firms use alternative sources of external financing, I modify my baseline specification in equation 2.1 and I disaggregate firms' external sources of financing into the following sub-accounts: supplier trade debt, accounts payable, debt with banking institutions, corporate bonds and other liabilities (table 2.3). In addition, I decompose supplier trade debt and debt with banking institutions per currency composition (domestic and foreign), and I disaggregate debt with banking institutions per term structure of debt (table 2.4). This complete disaggregation of external sources of financing enables me to test wether all sources of external financing negatively affect a firm's margin of exports.

As reported in table 2.3, exporters are less likely to export when they are externally financed by banking institutions or when they exhibit a high ratio of accounts payable. I find that relying on supplier trade debt enables firms to increase their intensive margin of exports, the number of foreign destinations reached, and the scope of products exported. A 10% increase in external financing obtained through supplier trade debt increases a firm's total volume of exports by 1.3 percent; equivalent to reaching one more export market destination. As discussed

[26]The number of observations in columns 2 through 5 decreases by 24,796 observations. As I explained, results in columns 2 through 5 are only obtained for firms exporting in periods t+1 and t.

previously, I separate supplier trade debt from all other sub-accounts classified as accounts payable. This is because the aggregate measure of accounts payable includes other sub-accounts that are not related to financing the purchasing of inputs for production. As reflected in my estimations, all other sub-accounts in accounts payable are negatively correlated with a firm's extensive margin of exports. I attribute this negative correlation to the fact that other accounts payable include pending labor debts and pending tax debts which directly affect firms' extensive margins of export.

In table 2.4, I disaggregate firms' external financing by currency composition and term structure. When firms use domestic debt with banking institutions as a source of external financing this negatively affects both their extensive and intensive margins of export. Short-term debt with domestic banking institutions affects entry into foreign market destinations, while long-term debt with domestic banking institutions is only related to a firm's intensive margin of exports. This affects both the firm's volume of exports and the number of countries to which the firm exports. As discussed previously, my estimates support the finding that supplier trade debt (domestic and foreign) smooths the negative effect of external financing with domestics banks on a firm's intensive margin of exports. Supplier trade debt is positively correlated with a firm's intensive margin of exports through the number of destinations reached and the number of products shipped.

Estimates in table 2.5 provide evidence that firms in financially dependant sectors benefit from having access to external financing. Firms in sectors that are dependent on external financing exhibit higher intensive margins of export when they are financed with short-term debt with foreign banking institutions.

During the crisis period, exporters are negatively affected by the short supply of credit. As reported in table 2.6, the short supply of debt with domestic banking institutions affects exporters most significantly.[27] The short supply of credit not only reduces export entry, but it also affects the intensive margin of exports directly through the reduction in financing, and indirectly by forcing exporters to

[27]Non-reported interactions between the crisis period, Rajan and Zingales's (1998) external financial dependance measure and the other sources of external financing are statistically equal to zero.

focus on exporting to their most profitable market destinations. Surprisingly, firms in financially dependent sectors were less affected by the credit shock. This finding aligns with Manova's (2010) argument that firms in financially dependant sectors secure external financing by paying higher returns on debt loans, in comparison to less productive firms classified in industries that rely less on external sources of financing.

Finally, I test whether the strong depreciation experienced by the Colombian peso negatively affected firms through a balance sheet effect on their debt denominated in foreign currency. Results in table 2.7 extend my baseline specification by interacting a firm's exchange rate specific variable with each of its sources of external financing. Although estimates for the interactions between a firm's external sources of financing and its exchange rates have the correct negative sign, I do not find any significant balance sheet effect of the depreciation of the exchange rate through debt in foreign currency.

2.5 Conclusions

Recent theoretical and empirical research on international trade provides evidence of the importance of external financing for exporters. As explained by Chaney (2005), Manova (2010) and Muûls (2008), financing fixed costs of exporting with external sources of debt restricts access into foreign market destinations as only highly productive firms can pay back their loans. However, when variable costs are financed with external sources of credit, both the extensive and intensive margins of trade are affected when firms rely on external sources of financing.

Inspired by the previous literate on firms' export performance and financial health, I first use a firm's leverage ratio to determine whether the firm is credit constrained. Second, I use this ratio to identify the firm's sources of external financing.

Using detailed information at the firm level for Colombian exporters, I test whether a firm's export margins are related to its leverage. Further, I test whether a firm's intensive and extensive margins of export are affected differently depending on the source of the firm's credit financing, and whether firms in financially dependant sectors exhibit a different relationship between their export margins and the external sources of financing. I also test whether, during periods of economic distress (e.g. a financial crisis), credit constrained firms grow at lower rates. I then push the argument a step forward by providing evidence that firms in financially dependant industries were actually less affected by the crisis. Finally, I test whether exporters were subject to a balance sheet effect when they hold debt in foreign currency.

My empirical results suggest that credit constraints affect both a firm's intensive and extensive margins of exports. Firms relying more on external financing are less likely to export, and credit constraints reduce firms' intensive margins of exports because they oblige firms to focus on the most profitable export market destinations. As illustrated by my results, it is only a few sources external financing that are related to a firm's export margins. Supplier trade debt is positively correlated with an increase in export market destinations and a firm's product scope. Debt with domestic banking institutions negatively affects a firm's extensive and the intensive margins of exports. Furthermore, I show that in financially dependant industries, firms relying on debt with foreign banking institutions grow at higher rates. During periods of crisis, it is the short supply of credit from domestic banking institutions that negatively affects exporting firms. Finally, I do not find evidence of a balance sheet effect on exporting firms.

Future research on this area should look at the potential substitution or complementarity between supplier trade debt and debt with financial institutions.

2.6 Bibliography

Amiti, M., and D. E. Weinstein (2009): "Exports and Financial Shocks," .

Beck, T. (2002): "Financial development and international trade Is there a link ?," *Journal of International Economics*, 57, 107–131.

——— (2003): "Financial dependence and international trade," *Review of International Economics*, 11(2), 296–316.

Bellone, F., P. Musso, L. Nesta, and S. Schiavo (2009): "Financial Constraints and Firm Export Behavior," *Working Paper*, pp. 1–40.

Berman, N., and A. Berthou (2006): "Exchange Rate Movements and International Trade under Foreign Currency Borrowing," .

Bleakley, H., and K. Cowan (2009): "Mishmash on Mismatch ? Balance-Sheet Effects and Emerging-Markets Crises," .

Braun, M., and B. Larrain (2005): "Finance and the Business Cycle : International , Inter-Industry Evidence," *Journal of Finance*, LX(3), 1097–1128.

Chaney, T. (2005): "Liquidity Constrained Exporters," .

Das, S., M. Roberts, and J. Tybout (2007): "Market Entry Costs, Producer Heterogeneity, and Export Dynamics," *Econometrica*, 75(3), 837–873.

Dell'Ariccia, G., Detragiache, E., and R. Rajan (2008): "The real effect of banking crises âIJĪ," *Journal of Financial Intermediation*, 17, 89–112.

Djankov, S., C. Freund, and C. Pham (2006): "Trading on Time," *World Bank Policy Research Paper*, (May).

Eaton, J., M. Eslava, M. Kugler, and J. R. Tybout (2007): "Export Dynamics in Colombia: Firm-Level Evidence.," .

——— (2008): "Exports Dynamics in Colombia: Transactions Level Evidence," .

Echeverry, J., L. Fergusson, R. Steiner, and C. Aguilar (2003): "'Dollar' debt in Colombian firms: are sinners punished during devaluations?," *Emerging Markets Review*, 4(4), 417–449.

Fisman, R., and I. Love (2003): "Trade Credit , Financial Intermediary Development and Industry Growth," *The Journal of Finance*, LVIII(1), 353–374.

Greenaway, D., A. Guariglia, and R. Kneller (2007): "Financial factors and exporting decisions," *Journal of International Economics*, 73, 377 – 395.

Iacovone, L., and V. Zavacka (2009): "Banking Crises and Exports Lessons from the Past," .

Kroszner, R., L. Laeven, and D. Klingebiel (2007): "Banking crises, financial dependence, and growth," *Journal of Financial Economics*, 84(1), 187–228.

Manova, K. (2010): "Credit Constraints , Heterogeneous Firms , and International Trade.," .

Melitz, M. (2003): "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity," *Econometrica*, 71(6), 1695–1725.

Muûls, M. (2008): "Exporters and credit constraints . A firm-level approach," .

Petersen, M. A. (1997): "Trade Credit:Theories and Evidence," *Rajan, Raghuram G.*, 10(3), 661–691.

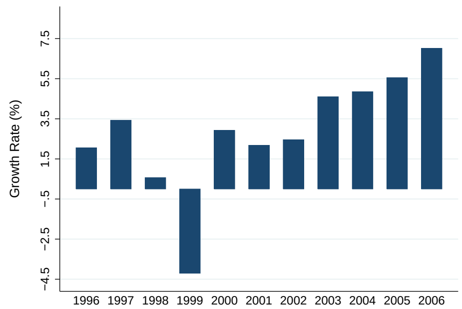
Rajan, R., and L. Zingales (1998): "Financial Dependence and Growth," *American Economic Review*, 88(3), 559–586.

Showalter, D. M. (1995): "Oligopoly and Financial Structure : Comment," *American Economic Review*, 85(3), 647–653.

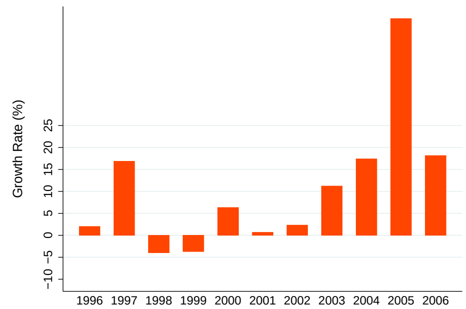
——— (1999): "Debt as an entry deterrent under Bertrand price competition," *Canadian Journal Of Economics*, 32(4), 1069–1081.

Villar, L., and H. Rincon (2001): "Capital Flows and Foreign Exchange Regimes in the Colombian Economy," .

Figures



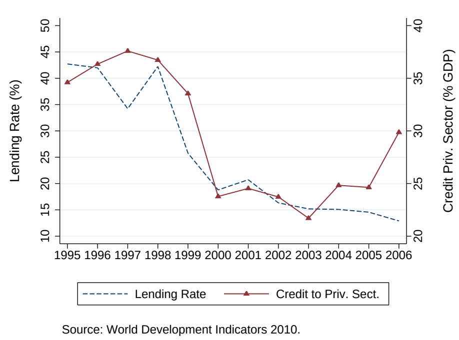
(a) GDP



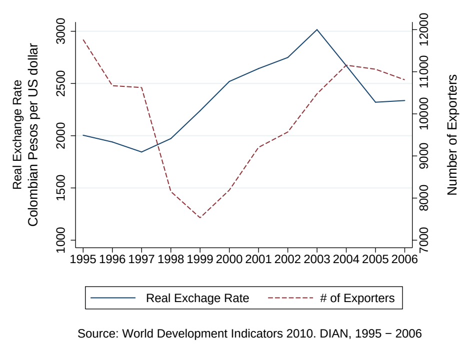
(b) Exports

Sources: World Development Indicators 2010 (WDI). Transaction Export Dataset - DIAN.

Figure 2.1: GDP and Total Export Growth 1996 – 2006.



(a) Lend.Rates - Cred.to Priv. Sect.



(b) Exchange Rates. - # Exp.Firms

Sources: World Development Indicators 2010 (WDI). Transaction Export Dataset - DIAN.

Figure 2.2: Evolution of Lending Rates, Credit to Private, Real Exchange Rate and # Exporting Firms 1995 – 2006.

Tables

Table 2.1: Summary Statistics.

Variable	Mean	Std.	Min.	Max
Dependent Variables				
Extensive Margin	.004	.357	-1	1
Δ Ln. Intensive Margin	.119	1.376	-14.638	11.769
Δ Foreign Market Destinations	.133	2.291	-35	33
Δ # Products Exported (HS 10)	.402	7.989	-184	127
Δ # Products Exported (HS 6)	.377	7.249	-177	105
RZ[b] External Sectoral Financial Depedance Ratio	.671	.236	-1.14	1.22
Regressors				
Δ Ln. Domestic Sales	.083	.59	-13.311	14.505
Tangible Assets Ratio[a]	.242	.197	.004	1
Real Exchange Rate Shock	.004	.098	-.866	.842
External Sources of Financing				
Leverage Ratio[a]	.472	.257	0	3.047
Supplier Trade Debt Ratio[a]	.123	.137	0	1.72
Accounts Payable Ratio[a]	.108	.142	0	2.877
Debt with Banking Inst. Ratio[a]	.155	.164	0	2.606
Corporate Bonds Ratio[a]	.001	.017	0	1.08
Other Liabilities Ratio[a]	.084	.103	0	1.728
External Sources of Financing per Term and Currency				
Domestic: Supplier Trade Debt Ratio[a]	.092	.115	0	1.28
Foreign: Supplier Trade Debt Ratio[a]	.031	.087	0	1.72
Short Term: Debt with Domestic Banking Inst. Ratio[a]	.083	.111	0	1.28
Long Term: Debt with Domestic Banking Inst. Ratio[a]	.04	.087	0	1.647
Short Term: Debt with Foreign Banking Inst. Ratio[a]	.004	.031	0	.897
Long Term: Debt with Foreign Banking Inst. Ratio[a]	.005	.039	0	.911

Sample: 1995-2006. Crisis Period: $1998-1999$. [a] As a ratio to Total Assets. See Appendix B: Definition of Variables for complete definition of variables.

Table 2.2: Export Margins and External Financing.

Regressors in t	Δ [dependant variable] Extensive Margin	Intensive Margin	# Dest.	# Prod. HS10	HS6
Δ Ln. Domestic Sales[b]	.007	-.084	.014	.272	.298
	(.007)	(.104)	(.104)	(.159)*	(.126)**
Tangible Assets Ratio[a]	-.007	.046	.130	-.248	-.258
	(.005)	(.080)	(.093)	(.237)	(.224)
Real Exchange Rate Shock	-.041	.668	-.142	.225	.235
	(.038)	(.139)***	(.117)	(.441)	(.390)
Leverage Ratio[a]	-.011	-.028	-.006	-.063	-.063
	(.003)***	(.045)	(.059)	(.167)	(.161)
Obs.	46691	21895	21895	21895	21895
R^2 (overall)	.003	.018	.004	.003	.002

Sample: $1995-2006$. Notes: Dependent variables across columns. Δ[dependent variable] is the difference of any dependent variable between t+1 and t. [a] Measured as a ratio to firms' Total Assets. [b] Differences in logarithm. See Appendix B: Definition of Variables for a complete definition of the variables. All specifications control for year and sector fixed effects. Standard errors in parenthesis are clustered per industry. ***, ** and * are significant at $1\%, 5\%$ and 10% respectively.

Table 2.3: Export Margins and Sources of External Financing.

Regressors in t	Δ [dependant variable] Extensive Margin	Intensive Margin	# Dest.	# Prod. HS10	HS6
Δ Ln. Domestic Sales[b]	.007	-.086	.012	.262	.290
	(.007)	(.103)	(.103)	(.158)*	(.126)**
Tangible Assets Ratio[a]	-.005	.086	.158	-.055	-.097
	(.005)	(.082)	(.085)*	(.257)	(.240)
Real Exchange Rate Shock	-.041	.669	-.141	.235	.245
	(.039)	(.138)***	(.118)	(.440)	(.389)
Supplier Trade Debt Ratio[a]	.004	.132	.144	.732	.617
	(.005)	(.057)**	(.107)	(.319)**	(.281)**
Accounts Payable Ratio[a]	-.026	-.098	.056	-.848	-.788
	(.009)***	(.069)	(.166)	(.397)**	(.370)**
Debt with Banking Inst. Ratio[a]	-.013	-.093	-.063	-.278	-.218
	(.002)***	(.084)	(.126)	(.297)	(.269)
Corporate Bonds Ratio[a]	.0009	-.412	-.122	-.624	-.186
	(.064)	(.253)	(.529)	(1.961)	(1.853)
Other Liabilities Ratio[a]	-.018	-.063	-.274	.091	.053
	(.013)	(.127)	(.120)**	(.511)	(.481)
Obs.	46691	21895	21895	21895	21895
R^2 (overall)	.003	.018	.004	.003	.003

Sample: $1995-2006$. Notes: Dependent variables across columns. Δ[dependent variable] is the difference of any dependent variable between t+1 and t. [a] Measured as a ratio to firms' Total Assets. [b] Differences in logarithm. See Appendix B: Definition of Variables for a complete definition of the variables. All specifications control for year and sector fixed effects. Standard errors in parenthesis are clustered per industry. ***, ** and * are significant at $1\%, 5\%$ and 10% respectively.

Table 2.4: Export Margins, Term Structure and Currency Composition of External Financing.

Regressors in t	Δ [dependant variable]				
	Extensive Margin	**Intensive Margin**	**# Dest.**	**# Prod.**	
				HS10	**HS6**
Δ Ln. Domestic Sales[b]	.007	-.087	.012	.262	.289
	(.007)	(.103)	(.103)	(.158)*	(.126)**
Tangible Assets Ratio[a]	-.006	.098	.182	-.062	-.103
	(.005)	(.079)	(.087)**	(.231)	(.214)
Real Exchange Rate Shock	-.040	.671	-.136	.247	.256
	(.039)	(.137)***	(.118)	(.441)	(.390)
Domestic: Supplier Trade Debt Ratio[a]	.002	.132	.102	.727	.655
	(.004)	(.084)	(.144)	(.351)**	(.309)**
Foreign: Supplier Trade Debt Ratio[a]	.020	.134	.221	.796	.611
	(.015)	(.089)	(.109)**	(.464)*	(.409)
Short Term: Debt with Domestic Banking Inst. Ratio[a]	-.014	-.048	.120	-.803	-.652
	(.001)***	(.114)	(.172)	(.495)	(.451)
Long Term: Debt with Domestic Banking Inst. Ratio[a]	.007	-.281	-.365	-.420	-.365
	(.014)	(.091)***	(.169)**	(.472)	(.435)
Short Term: Debt with Foreign Banking Inst. Ratio[a]	.008	.130	-.143	4.274	3.904
	(.038)	(.217)	(.378)	(2.670)	(2.492)
Long Term: Debt with Foreign Banking Inst. Ratio[a]	-.0002	.189	.412	.513	.574
	(.035)	(.213)	(.327)	(.810)	(.767)
Accounts Payable Ratio[a]	-.025	-.087	.083	-.841	-.779
	(.009)***	(.068)	(.167)	(.373)**	(.347)**
Corporate Bonds Ratio[a]	-.004	-.384	-.069	-.686	-.238
	(.064)	(.265)	(.542)	(2.031)	(1.916)
Other Liabilities Ratio[a]	-.017	-.050	-.244	.097	.065
	(.013)	(.127)	(.120)**	(.518)	(.487)
Obs.	46691	21895	21895	21895	21895
R^2 (overall)	.003	.019	.005	.004	.003

Sample: $1995-2006$. Notes: Dependent variables across columns. Δ[dependent variable] is the difference of any dependent variable between t+1 and t. [a] Measured as a ratio to firms' Total Assets. [b] Differences in logarithm. See Appendix B: Definition of Variables for a complete definition of the variables. All specifications control for year and sector fixed effects. Standard errors in parenthesis are clustered per industry. ***, ** and * are significant at $1\%, 5\%$ and 10% respectively.

Table 2.5: Export Margins and External Financing in Financially Dependent Industries.

	Δ [dependant variable]				
Regressors in t	**Extensive Margin**	**Intensive Margin**	**# Dest.**	**# Prod.** **HS10**	**HS6**
Δ Ln. Domestic Sales[b]	.007	-.087	.011	.262	.290
	(.007)	(.103)	(.103)	(.158)*	(.126)**
Tangible Assets Ratio[a]	-.006	.104	.185	-.051	-.092
	(.005)	(.079)	(.087)**	(.231)	(.215)
Real Exchange Rate Shock	-.041	.673	-.134	.247	.257
	(.039)	(.138)***	(.117)	(.440)	(.390)
Domestic: Supplier Trade Debt Ratio[a]	.004	.023	-.141	-1.016	-.904
	(.019)	(.164)	(.294)	(.856)	(.781)
Foreign: Supplier Trade Debt Ratio[a]	.058	-.249	-.182	.134	.086
	(.058)	(.270)	(.394)	(1.157)	(1.068)
Short Term: Debt with Domestic Banking Inst. Ratio[a]	-.023	-.320	.212	-.118	-.171
	(.007)***	(.241)	(.428)	(1.286)	(1.196)
Long Term: Debt with Domestic Banking Inst. Ratio[a]	.005	-.310	-.531	.723	.529
	(.043)	(.191)	(.555)	(1.070)	(.959)
Short Term: Debt with Foreign Banking Inst. Ratio[a]	-.118	-1.854	-.992	7.311	7.418
	(.111)	(.684)***	(1.240)	(8.160)	(7.665)
Long Term: Debt with Foreign Banking Inst. Ratio[a]	.020	.327	.631	.814	.838
	(.097)	(.460)	(.866)	(2.369)	(2.259)
Accounts Payable Ratio[a]	-.013	.022	.099	-.870	-.883
	(.026)	(.204)	(.352)	(.651)	(.620)
Corporate Bonds Ratio[a]	.141	.062	2.305	-9.531	-7.294
	(.252)	(.981)	(3.295)	(5.002)*	(4.882)
Other Liabilities Ratio[a]	-.044	-.619	-.648	.836	.624
	(.038)	(.308)**	(.423)	(1.470)	(1.363)
Domestic: Supplier Trade Debt Ratio[a] × RZ Ext.Fin.	-.003	.160	.368	2.585	2.316
	(.040)	(.183)	(.339)	(1.446)*	(1.303)*
Foreign: Supplier Trade Debt Ratio[a] × RZ Ext.Fin.	-.050	.520	.555	.931	.745
	(.073)	(.367)	(.494)	(1.722)	(1.553)
Short Term: Debt with Domestic Banking Inst. Ratio[a] × RZ Ext.Fin.	.031	.383	-.128	-.958	-.671
	(.027)	(.259)	(.501)	(1.897)	(1.716)
Long Term: Debt with Domestic Banking Inst. Ratio[a] × RZ Ext.Fin.	.004	.039	.273	-1.749	-1.363
	(.065)	(.292)	(.764)	(1.927)	(1.653)
Short Term: Debt with Foreign Banking Inst. Ratio[a] × RZ Ext.Fin.	.176	2.668	1.156	-4.057	-4.692
	(.123)	(.991)***	(1.612)	(8.256)	(7.939)
Long Term: Debt with Foreign Banking Inst. Ratio[a] × RZ Ext.Fin.	-.026	-.177	-.268	-.449	-.385
	(.125)	(.553)	(.978)	(3.092)	(2.977)
Accounts Payable Ratio[a] × RZ Ext.Fin.	-.017	-.167	-.014	.084	.197
	(.038)	(.301)	(.405)	(.872)	(.820)
Corporate Bonds Ratio[a] × RZ Ext.Fin.	-.181	-.558	-2.969	11.107	8.865
	(.313)	(1.182)	(4.084)	(5.779)*	(5.486)
Other Liabilities Ratio[a] × RZ Ext.Fin.	.043	.861	.618	-1.150	-.872
	(.056)	(.456)*	(.627)	(2.349)	(2.202)
Obs.	46691	21895	21895	21895	21895
R^2 (overall)	.003	.019	.005	.004	.004

Sample: $1995-2006$. Notes: Dependent variables across columns. Δ[dependent variable] is the difference of any dependent variable between t+1 and t. [a] Measured as a ratio to firms' Total Assets. [b] Differences in logarithm. See Appendix B: Definition of Variables for a complete definition of the variables. All specifications control for year and sector fixed effects. Standard errors in parenthesis are clustered per industry. ***, ** and * are significant at $1\%, 5\%$ and 10% respectively.

Table 2.6: Export Margins and the Crisis Period.

Regressors in t	Δ [dependant variable] Extensive Margin	Intensive Margin	# Dest.	# Prod. HS10	HS6
RZ Ext.Fin. × Crisis Period	-.078	-.202	-.636	-.443	-.415
	(.042)*	(.266)	(.410)	(1.135)	(1.043)
Short Term: Debt with Domestic Banking Inst. Ratio[a]	-.013	-.136	.626	-.043	-.183
	(.008)*	(.269)	(.501)	(1.381)	(1.288)
Short Term: Debt with Domestic Banking Inst. Ratio[a] × RZ Ext.Fin.	-.008	.220	-.646	-.386	-.049
	(.029)	(.292)	(.608)	(2.057)	(1.877)
Short Term: Debt with Domestic Banking Inst. Ratio[a] × Crisis Period	-.320	-1.444	-3.044	-.887	-.222
	(.170)*	(.636)**	(1.113)***	(3.656)	(3.455)
Short Term: Debt with Domestic Banking Inst. Ratio[a] × RZ Ext.Fin. × Crisis Period	.559	1.346	3.678	-3.537	-3.921
	(.269)**	(.796)*	(1.449)**	(5.142)	(4.857)
Short Term: Debt with Foreign Banking Inst. Ratio[a]	-.101	-1.750	-.510	10.013	9.981
	(.132)	(.787)**	(1.289)	(9.215)	(8.683)
Short Term: Debt with Foreign Banking Inst. Ratio[a] × RZ Ext.Fin.	.185	2.491	.796	-6.645	-7.159
	(.140)	(1.095)**	(1.655)	(9.534)	(9.219)
Short Term: Debt with Foreign Banking Inst. Ratio[a] × Crisis Period	-.006	-.649	-4.012	-19.844	-18.651
	(.345)	(2.350)	(4.274)	(10.217)*	(9.761)*
Short Term: Debt with Foreign Banking Inst. Ratio[a] × RZ Ext.Fin. × Crisis Period	-.143	1.039	3.703	19.829	18.661
	(.421)	(2.764)	(5.171)	(12.207)	(11.766)
Obs.	46691	21895	21895	21895	21895
R^2 (overall)	.004	.02	.006	.005	.004

Sample: $1995-2006$. Notes: Dependent variables across columns. Δ[dependent variable] is the difference of any dependent variable between t+1 and t. [a] Measured as a ratio to firms' Total Assets. [b] Differences in logarithm. See Appendix B: Definition of Variables for a complete definition of the variables. I do not report the interactions between other external sources of financing, the crisis period and the Rajan and Zingales's (1998) measure of external dependance. The corresponding estimates of these regressors were are all statistically equal to zero. All specifications control for year and sector fixed effects. Standard errors in parenthesis are clustered per industry. ***, ** and * are significant at 1%, 5% and 10% respectively.

Table 2.7: Export Margins and the Balance Sheet Effect.

Regressors in t	Δ [dependant variable]				
	Extensive Margin	**Intensive Margin**	**# Dest.**	**# Prod.**	
				HS10	**HS**6
Δ Ln. Domestic Sales[b]	.007	-.086	.012	.261	.289
	(.006)	(.103)	(.103)	(.158)*	(.126)**
Tangible Assets Ratio[a]	-.006	.102	.184	-.060	-.101
	(.005)	(.079)	(.086)**	(.231)	(.214)
Real Exchange Rate Shock	-.119	.442	-.027	1.084	.987
	(.046)**	(.267)*	(.321)	(.871)	(.816)
Domestic: Supplier Trade Debt Ratio[a]	.002	.131	.097	.737	.663
	(.004)	(.087)	(.145)	(.352)**	(.310)**
Foreign: Supplier Trade Debt Ratio[a]	.020	.130	.221	.798	.612
	(.015)	(.089)	(.111)**	(.466)*	(.412)
Short Term: Debt with Domestic Banking Inst. Ratio[a]	-.006	-.049	.122	-.788	-.639
	(.008)	(.115)	(.174)	(.495)	(.451)
Long Term: Debt with Domestic Banking Inst. Ratio[a]	.006	-.289	-.377	-.411	-.358
	(.014)	(.093)***	(.176)**	(.459)	(.424)
Short Term: Debt with Foreign Banking Inst. Ratio[a]	.015	.147	-.131	4.290	3.912
	(.038)	(.224)	(.392)	(2.760)	(2.568)
Long Term: Debt with Foreign Banking Inst. Ratio[a]	.007	.208	.352	.673	.674
	(.038)	(.243)	(.319)	(.808)	(.756)
Accounts Payable Ratio[a]	-.025	-.103	.088	-.845	-.783
	(.009)***	(.068)	(.168)	(.384)**	(.356)**
Corporate Bonds Ratio[a]	.003	-.393	-.096	-.674	-.202
	(.061)	(.265)	(.540)	(2.008)	(1.907)
Other Liabilities Ratio[a]	-.017	-.056	-.251	.069	.041
	(.014)	(.129)	(.121)**	(.525)	(.494)
Domestic: Supplier Trade Debt Ratio[a] × Real Exchange Rate Shock	.385	1.072	2.318	2.229	2.194
	(.188)**	(1.227)	(1.291)*	(4.145)	(3.948)
Foreign: Supplier Trade Debt Ratio[a] × Real Exchange Rate Shock	-.201	-.321	-1.161	-2.991	-3.457
	(.200)	(1.018)	(1.279)	(4.642)	(3.920)
Short Term: Debt with Domestic Banking Inst. Ratio[a] × Real Exchange Rate Shock	.159	-.174	-1.938	-5.698	-5.123
	(.139)	(1.271)	(1.295)	(5.467)	(4.918)
Long Term: Debt with Domestic Banking Inst. Ratio[a] × Real Exchange Rate Shock	.115	.126	.331	-.655	-.575
	(.265)	(.733)	(1.439)	(2.380)	(2.193)
Short Term: Debt with Foreign Banking Inst. Ratio[a] × Real Exchange Rate Shock	-.747	-1.495	-1.191	-1.483	-.940
	(.704)	(2.088)	(4.222)	(15.111)	(13.737)
Long Term: Debt with Foreign Banking Inst. Ratio[a] × Real Exchange Rate Shock	-.242	-.491	2.012	-5.827	-3.797
	(.539)	(1.851)	(2.293)	(6.772)	(6.580)
Accounts Payable Ratio[a] × Real Exchange Rate Shock	.230	2.011	-.909	.705	.761
	(.150)	(.526)***	(.883)	(2.947)	(2.717)
Corporate Bonds Ratio[a] × Real Exchange Rate Shock	-1.082	.749	4.621	-3.098	-5.443
	(.934)	(2.043)	(5.880)	(15.143)	(13.469)
Other Liabilities Ratio[a] × Real Exchange Rate Shock	.167	-.278	-.690	-4.902	-4.251
	(.262)	(1.090)	(.953)	(5.089)	(4.666)
Obs.	46691	21895	21895	21895	21895
R^2 (overall)	.003	.019	.005	.004	.003

Sample: $1995-2006$. Notes: Dependent variables across columns. Δ[dependent variable] is the difference of any dependent variable between t+1 and t. [a] Measured as a ratio to firms' Total Assets. [b] Differences in logarithm. See Appendix B: Definition of Variables for a complete definition of the variables. All specifications control for year and sector fixed effects. Standard errors in parenthesis are clustered per industry. ***, ** and * are significant at 1%, 5% and 10% respectively.

Appendix

Appendix A: Regulation and Firm Inclusion Criteria - SS dataset

To our knowledge and since 1993, the minimum threshold requirement has been modified in three different opportunities. Decree 1258 of 1993 initially established that firms with only assets over the equivalent of 20,000 times the minimum monthly wage should report its financial statement to SS. Decree 3100 of 1997 did not modified the size of the requirement but modified the financial account under upon which the level was set. From now on, the threshold was set using firms' total assets or total sales. Decree 4350 of 2006 increased the minimum monthly wage multiple up to 30,000 times the total level of assets or sales of the firm.

Therefore, commercial firms should report their financial statements to SS if they meet any of the following two criteria:

i) Technical requirement: firms should report to SS if their level of assets or sales is above a minimum threshold currently set at thirty thousand times the current minimum monthly wage. As of year 2010, this threshold was set at approximately 7.4 U.S. millions dollars. Firms that submit their financial information under this criteria are classified in the dataset as "vigiladas".

ii) Regulation Requirement: For regulation purposes the superintendent in charge might decide to include firms in the survey even in they fail to accomplish the technical rule requirement specified under requirement *i*. In terms of the dataset, firms that entered the survey under this distinction are either classified as "Inspeccionadas" or "Controladas". "Inspeccionadas" are firms that are included by direct decision of the superintendent. This is usually applied to firms classified in specific economic sectors. "Controladas" are firms that by direct petition of the stakeholders, or by judicial requirements are require to report to SS their financial statements for further accounting inspections.

In some rare occasions a third type of firm is included within the data

"Exentas". These are firms that even though they are not oblige to report SS they choose to report their financial statements.

Appendix B: Definition of Variables

Export growth t+1 to t. Measured as the difference between the logarithm of a firm's exports in periods t+1 and t.

Δ Domestic Sales: Measured as the difference between the logarithm of domestic sales in periods t+1 and t.

Tangible Assets: Ratio of tangible assets to total assets in period t.

Leverage Ratio: Ratio of total liabilities to total assets in period t.

Crisis Period 1998-1999: Dummy variable that takes the value of 1 in years 1998-1999 and 0 otherwise.

Exchange Rate Shock t+1 to t:$\sum_c \alpha_{i,t,c} \left[\widetilde{RER_{i,t+1,c}} - \widetilde{RER_{i,t,c}} \right]$. $\widetilde{RER_{i,t,c}}$ corresponds to the Bilateral real exchange rate in period t between Colombia and country c. We use producer price indexes for the corresponding deflators. Where $\alpha_{i,t,c} = \frac{\exp_{i,t,c}}{totexports_{i,t,c}}$.

Accounts Payable:Ratio of accounts payable excluding supplier trade debt to total assets. As a difference to Fisman and Love (2003), this account is the sum of liabilities with third agents that are not use to finance inputs related to production. Measured in period t.

Supplier Debt: Ratio of supplier trade debt to total assets. Supplier trade debt is always reported as a debt to be accrue within a year, implying that it is always a short term debt. Measured in period t.

Domestic Supplier Trade Debt: Ratio of domestic supplier trade debt to total assets in period t.

Foreign Supplier Trade Debt: Ratio of foreign supplier trade debt to total assets in period t.

Account Receivable: Ratio of accounts receivable to to total assets in period t.

Debt with Banking Institutions: Ratio of total debt with banking institutions to total assets in period t. Total debt with banking institutions is define as the sum of debt with domestic and foreign banking institutions.

Corporate Bonds Ratio: Ratio of corporate bonds to total assets in period t.

Other Liabilities: Ratio of other liabilities to total assets in period t.

Short Term debt with Domestic Banking Institutions: Ratio of debt with domestic banking institutions with maturity within one year to total assets in period t.

Long Term Debt with Domestic Banking Institutions: Ratio of debt with domestic banking institutions with maturity of more than one year to total assets in period t.

Short Term Debt with Foreign Banking Institutions:Ratio of debt with foreign banking institutions with maturity within one year to total assets in period t.

Long Term Debt with Foreign Banking Institutions:Ratio of debt with foreign banking institutions with maturity of more than one year to total assets in period t.

Chapter 3

Air Transport Costs

Abstract

In this paper I develop a heterogenous model of international trade with endogenous air shipping costs. I introduce an air transport sector characterized by identical global air cargo carriers competing à la Cournot, with fixed entry costs into air cargo shipping. I derive optimal pricing rules characterized by markups depending on the number of cargo carriers. Comparative statics on air shipping prices show that a change in any determinant of cargo shipping affects prices directly, and also indirectly through an adjustment in the number of carriers. A change in the number of carriers not only impacts air shipping prices, but it also affects a manufacturer's delivery price, total demand, and export revenue. Thus, the endogenous reaction of the number of cargo carriers enables me to derive a model with welfare gains in trade that are larger than those achieved in the conventional Melitz's (2003) model. Estimates suggest that a 10% increment in air cargo competition reduces cargo shipping prices by 1%.

Keywords: International trade; Transport Costs; Competition.

JEL Classification: F12.

3.1 Introduction

Between 1980 and 2010, world economies became more integrated. World trade grew at an annual average rate of 8.45%, and trade measured as ratio to GDP increased by 76.5%.[1] However, the real costs of international trade deter countries from fully enjoying its benefits. Estimates in trade literature suggest that overall trade costs amount to an import tariff rate of 170%. As Anderson and van Wincoop (2004) suggest, 55% of this rate is associated with retail and wholesale distribution costs, 44% is associated with border-related trade barriers, and 21% is directly related to transport costs. Understanding the factors behind each trade cost component provides an opportunity to determine a country's ability to fully participate in the global economy.

In this paper, I depart from the usual assumption of exogenous iceberg transport costs and I develop a heterogenous model of trade with endogenous transport costs. I assume that the service of international cargo shipping is provided by identical global air cargo carriers competing in a oligopolistic market structure à la Cournot with fixed entry costs. As in Melitz (2003), a manufacturer's total cost structure is determined by a manufacturer-specific constant marginal production cost, an international shipping cost, and a fixed production cost. In this model, a manufacturer's productivity draw not only determines a manufacturer's marginal production costs, but it also determines the per unit shipping weight content of the exported cargo. This implies that, within a sector, highly productive manufacturers not only produce goods with lower marginal production costs, but they also export products with lower per unit shipping weight content.

Cournot competition enables me to obtain optimal shipping prices determined by a markup over constant handling cargo costs. The markup depends on the number of carriers per route, while handling cargo costs are determined by a carrier's productivity level, an airport's marginal handling cost, and the cost of jet fuel. Comparative statics on air shipping prices enable me to show that the net effect of a change of an exogenous parameter affects shipping prices directly, and indirectly through the adjustment of the number of carriers. By construction, the

[1] In comparison to the level achieved in 1980.

endogenous response of the number of cargo carriers not only impacts air shipping prices, but also affects a manufacturer's delivery price, total demand and export revenue. Thus, the endogenous adjustment in competition in air cargo enables me to derive a model with welfare adjustments higher than those achieved by Melitz (2003).

To test the importance of competition in air cargo shipping, I use the US Import of Merchandize data set joint with other sources to construct an unbalanced panel dataset containing $696,981$ observations, with information related to air shipping costs, cargo weight and a product's price for $13,401$ products defined at the 10 digit level of the harmonized system code for the period between 1990 and 2009. Additional data includes the number of carriers per cargo route and a country's airport cargo handling costs. Empirical results suggest that air shipping prices are higher when transportation is performed through airports characterized with higher marginal cargo fees. Similarly, shipping prices decrease as competition in air cargo shipping increases. In all specifications, results are significant at 1%, and the magnitude of the estimated coefficients do not seem to vary as I control for product characteristics affecting the marginal handling costs of cargo shipping, or as I control for the competition arising from other transport modes.

My findings contribute to and build upon a wealth of literature in this field. In particular, this paper is closely related to two strands of the trade literature. First, the paper is related to the literature of firm heterogeneity. Similar to Melitz and Ottaviano (2008), I derived an optimal pricing rule for imported products that exhibit an endogenous markup. However, I offer an alternative way of deriving product import prices with varying markups. In this model, the oligopolistic market structure in air cargo implies that cargo carriers exhibit a pricing rule with a markup determined by the number of cargo carriers. In Melitz and Ottaviano (2008), the varying markup property is obtained because of the assumption made on a consumer's utility function. Second, this paper is also related to the literature studying the determinants of international cargo shipping. Initial empirical findings by Limão and Venables (2001), Clark, Dollar, and Micco (2004) and Micco and Serebrisky (2006) provide evidence of the reducing effect of an improvement in a country's infrastructure on both ocean and air cargo shipping prices. But as explained in Hellermann (2006), the market structure in cargo shipping is an important factor that should not be disregarded when analyzing the determinants of prices in cargo industry. Moving in this direction, Hummels, Lugovskyy, and Skiba (2009) provide evidence of the importance of competition in determining ocean cargo transport prices. Inspired by their approach, I endogenize transport costs assuming that carriers compete in an oligopolistic market structure à la Cournot. However, my paper differs in two ways: First, I focus my attention on air cargo shipping. Second, I derive a general equilibrium model of trade with a transportation sector characterized by an oligopolistic market structure with the additional assumption that air carriers incur in fixed entry costs into air cargo shipping. This additional assumption enables me to identify the factors determining entry into air cargo shipping. Thus, the endogenous response of the number of cargo carriers proves to be the key element to understand why in the comparative statics of the model I find higher welfare effects.

This paper is structured as follows: Section 3.2 derives the model; Section 3.3 formulates the empirical estimation strategy, describes the data and discusses the results; and finally, section 3.4 concludes.

3.2 The Model

3.2.1 Set-up

Consider an economy with two countries; home (denoted by sub-index 1) and foreign (denoted by sub-index 2). In both countries, labor is the only factor of production, and market size in each country is L_1 and L_2, respectively. Each country has three sectors: 1) A sector that produces a freely traded homogeneous good; 2) A sector producing a continuum of differentiated goods; and 3) An transportation sector composed by global air cargo carriers and airport entities.

In both countries, the homogeneous good is produced under a constant returns to scale production function $q_{oj} = \alpha_o \ell_{oj} \quad \forall \;\; j = 1, 2$. α_o is the labor productivity and ℓ_{oj} is the labor required to produce q_{oj} units. In both countries, wages are set by the productivity level of the homogenous good as $\frac{w_j}{p_o} = \alpha_o \quad \forall \quad j = 1, 2$. I set this good as the numeraire ($p_o = 1$). Since the productivity level is the same across destinations, wages in both countries are the same $w_1 = w_2 = \alpha_o$. This implies that the homogenous good is locally produced in both markets, and that no trade should be expected as marginal productions costs are the same.

As in Melitz (2003), production of differentiated goods is performed by monopolistically competitive firms with heterogenous constant marginal costs of production and increasing returns to scale. When exporting, firms incur a transportation cost which is payed to a cargo carrier.

The transportation sector is composed by airport entities and N^c identical global air cargo carriers. Within each country, airports are identical agents with a cost structure characterized by constant marginal costs. Airports charge cargo carriers a handling fee for the cargo load transported when arriving and departing. For simplicity, I assume that the optimal price of cargo handling is set at the airport's marginal cost $\frac{w}{\varepsilon_j}$. ε_j is the infrastructure level which I assume to be country specific and I also take as given.

Global air cargo carriers are identical agents competing in an oligopolistic market structure à la Cournot. As in Mas-Collel, Whinston, and Green (1995), I introduce entry into an oligopolistic market structure by first allowing potential cargo carriers to simultaneously decide if they want to "enter" or "stay out" of the cargo route. Entrants pay a route specific set up cost of wF^a. In a second stage, once the setup costs are sunk, competing carriers compete à la Cournot.[2]

Every consumer is endowed with one unit of labor, $\theta_j \quad \forall \quad j = 1, 2$ ownership shares of local firms, and θ_w ownership shares of airports and air cargo carriers.[3] For every imported variety, consumers pay an ad-valorem import tariff $\tau_j \quad \forall \quad i = 1, 2$ that without loss of generality I assume to be equal across varieties.[4] Tax revenues

[2]For further details refer to Mas-Collel, Whinston, and Green (1995) section 12E.

[3]$\theta_j = \frac{1}{L_j} \quad \forall \quad j = 1, 2$. $\theta_w = \frac{1}{L_1 + L_2}$.

[4]Alternatively, I could also assume that the import tax could be payed by foreign manufacturing firms. In this case $p^c_{\omega j} = \frac{1}{1 - \tilde{\tau}_j} p_{\omega i} \quad \forall \quad i, j = 1, 2$. $\tilde{\tau}_j < 1$, and is the ad-valorem import tax. Regardless of who bears the import tax, $p^c_{\omega j}$ exhibits a functional form that is similar to the achieve when consumers pay for the import tax. Notice that $p^c_{\omega j}$ will be the same when $\tau_j = \frac{1}{1 - \tilde{\tau}_j}$.

are redistributed as a lump sum transfer within the country's population.

3.2.2 Demand

Consumers exhibit quasi-linear preferences defined over a homogeneous good q_{oj}, and a set Ω of differentiated products.[5] A representative consumer in market j has a utility function

$$U_j = q_{oj} + \int_{\omega \in \Omega} \frac{\sigma}{\sigma - 1} q_\omega^{\frac{\sigma-1}{\sigma}} \mathrm{d}\omega, \quad \sigma > 1, \quad \forall \ \ j = 1, 2. \tag{3.1}$$

σ is the consumer price elasticity of demand of differentiated goods, assumed to be elastic. Imported varieties produced in foreign country i are sold to consumers in market j at a per unit price $p^c_{\omega j} = p_{\omega j}\tau_j$. $p_{\omega j}$ is the supplier price and τ_j is the generalized per unit ad-valorem import tariff. As expected, when the product is locally produced $\tau_j = 1$. Individual consumption of the homogeneous good and all varieties are:

$$q_{oj} = \frac{I_j}{p_o} - \left[\frac{\bar{P}_j}{p_o}\right]^{1-\sigma} \quad \text{and} \quad q_{\omega j} = \left[\frac{p_o}{p_{\omega i}\tau_j}\right]^{\sigma}; \tag{3.2a}$$

$$\text{where} \quad \bar{P}_j = \left[\int_{\omega \in \Omega_j} p^{c\ 1-\sigma}_{\omega} \mathrm{d}\omega\right]^{\frac{1}{1-\sigma}}. \tag{3.2b}$$

$\bar{P}_j$ and I_j are, respectively, the price index and the income level of the representative consumer in market j. As with the CES preference structure, quasi-linear preferences imply that the delivery price elasticity for any variety ω is constant and is equal to $-\sigma$. However, two considerations should be taken into account: First, under the traditional CES preference structure, demand functions for any differentiated varieties are determined by the variety's own delivery price, the price index

[5] $\Omega = \Omega_1 \cup \Omega_2$

and the income allocated to the consumption of all varieties.[6] With quasi-linear preferences the demand function of every differentiated variety is only determined by the price ratio between the numeraire and the variety's own delivery price (equation 3.2a). This implies that income and cross price elasticities of differentiated varieties are all equal to zero, and a change in a consumer's income level only has a direct effect on the consumption of the homogenous good. Second, quasi-linear preferences imply that the demand function of differentiated varieties do not depend on the price index. This does not represent an issue since endogenizing air shipping prices enables me to show that factors determining the price index also determine a variety's own delivery price. This result enables me to derive demand changes that before where only possible to be obtained when assuming CES preferences, as the effect on demand was driven by the adjustment of the price index. Now, I'm able to derive similar results with a simpler functional form.

3.2.3 Production

A continuum of manufacturing firms each produce a variety ω. Labor is the only factor required for production, and a manufacturer's technology is provided by a cost function characterized by a constant marginal cost and a destination specific fixed overhead cost $wF_j \quad \forall \quad j = 1, 2$. A firm's marginal production cost is determined by its productivity level φ, drawn from the known distribution $g(\varphi)$, defined over the positive support $(0, \infty)$, and characterized by the continuous cumulative distribution function $G(\varphi)$. Manufacturers with a higher productivity draw exhibit lower marginal production costs. Fixed overhead costs are market specific and foreign manufacturers incur higher overhead costs (e.g. $F_1 > F_2$) for manufacturing firms exporting to foreign market 1).

Depending on the productivity draw, a manufacturing firm can produce for its own domestic market, or it can also produce for the foreign market. When exporting, manufacturers incur shipping costs determined by the total weight of

[6]Under CES preferences, a consumer's utility function is $U_j = q_{oj}^{\alpha} \left[\int_{\omega \in \Omega_1} q_{\omega}^{\frac{\sigma-1}{\sigma}} \right]^{(1-\alpha)\frac{\sigma}{\sigma-1}}$. α is the income share allocated to consumption of all varieties. In this case, optimal demand of any variety ω is $(1-\alpha) I_j \frac{p_{\omega}^{-\sigma}}{P_j^{1-\sigma}}$.

the exported cargo. The cost structure of a manufacturer exporting to market 1 is

$$TC_2 = \frac{w}{\varphi} q_{\varphi 2} + wF_2 \quad \text{and} \tag{3.3a}$$

$$TC_1 = \frac{w}{\varphi} q_{\varphi 1} + f_1 h(\varphi) q_{\varphi 1} + wF_1. \tag{3.3b}$$

Equation 3.3a corresponds to the total cost incurred when a firm produces for its own domestic market, while equation 3.3b is the total cost when a firm chooses to export. Exporting is a more expensive activity. On the one hand, exporters incur higher fixed overhead costs. On the other hand, exporters incur product-specific shipping costs determined by the per kilogram shipping price f_1 and by the total weight content of the exported cargo $h(\varphi)q_{\varphi 1}$. Under this setup, a firm's productivity draw not only determines the marginal production cost $\frac{w}{\varphi}$, but it also determines a product's per unit shipping weight content $h(\varphi)$. Highly productive manufacturers not only produce products with lower marginal production costs, but they are also the cleverest at exporting products with better shipping attributes; namely lower shipping weight. Then $h(\varphi)$ is a continuous differentiable function that is inversely related to a manufacturer's productivity draw; i.e., $\frac{\partial h}{\partial \varphi} < 0$. To keep the model as tractable as possible, I assume that a product's per unit shipping weight $h(\varphi)$ is equal to $\frac{\nu}{\varphi}$. ν is a weight parameter that is common to all the products classified within the sector. Manufacturers with a productivity draw higher than ν will produce goods with lower per unit shipping costs $(f_1 h(\varphi))$.

A product's optimal pricing rule when producing for the domestic and the foreign market is determined by a mark-up over the marginal costs:

$$p_{\varphi 2} = \frac{\sigma}{\sigma - 1} \frac{w}{\varphi} \quad , \tag{3.4a}$$

$$p_{\varphi 1} = \frac{\sigma}{\sigma - 1} \left[\frac{w}{\varphi} + \frac{\nu f_1}{\varphi} \right]. \tag{3.4b}$$

These pricing choices imply that a manufacturer located in country 2, having drawn a productivity level φ, could make a profit in the domestic market π_2

and a profit abroad π_1:

$$\pi_2 = \left[\frac{\varphi\left(\sigma-1\right)}{w}\right]^{\sigma-1}\left[\frac{p_o}{\sigma}\right]^{\sigma}\mathrm{L}_2 - wF_2 \quad , \tag{3.5a}$$

$$\pi_1 = \left[\frac{\varphi\left(\sigma-1\right)}{w+\nu f_1}\right]^{\sigma-1}\left[\frac{p_o}{\sigma\tau_1}\right]^{\sigma}\mathrm{L}_1 - wF_1 \quad . \tag{3.5b}$$

As in Melitz (2003), only manufacturers that are able to profit domestically will survive, and those who can profitably produce to foreign market destinations will be active in equilibrium. The endogenous productivity thresholds for entry into the domestic and foreign market are:[7]

$$\underline{\varphi}_2 = \left[\frac{w}{\sigma-1}\right]\left[\frac{wF_2}{\mathrm{L}_2}\right]^{\frac{1}{\sigma-1}}\left[\frac{\sigma}{p_o}\right]^{\frac{\sigma}{\sigma-1}} \quad \text{and} \tag{3.6a}$$

$$\underline{\varphi}_1 = \left[\frac{w+\nu f_1}{\sigma-1}\right]\left[\frac{wF_1}{\mathrm{L}_1}\right]^{\frac{1}{\sigma-1}}\left[\frac{\sigma\tau_1}{p_o}\right]^{\frac{\sigma}{\sigma-1}} \quad . \tag{3.6b}$$

This implies that the total demand for air cargo transportation when shipping products to countries 1 and 2 are [8]

$$W_1 = \nu\mathrm{L}_1\left[\frac{p_o\left(\sigma-1\right)}{\sigma\tau_1\left(w+\nu f_1\right)}\right]^{\sigma}\int_{\underline{\varphi}_1}^{\infty}\varphi^{\sigma-1}\mathrm{d}G\left(\varphi\right) \quad \text{and} \tag{3.7a}$$

$$W_2 = \nu\mathrm{L}_2\left[\frac{p_o\left(\sigma-1\right)}{\sigma\tau_2\left(w+\nu f_2\right)}\right]^{\sigma}\int_{\underline{\tilde{\varphi}}_2}^{\infty}\varphi^{\sigma-1}\mathrm{d}G\left(\varphi\right). \tag{3.7b}$$

I find that the price elasticity of cargo is equal to the sum of two effects

[7] If both countries have the same market size, $\underline{\varphi}_1$ will be always be greater than $\underline{\varphi}_2$ since $F_1 > F_2$. But, under asymmetrical market sizes we need to assume that $\frac{\mathrm{L}_2}{\mathrm{L}_1} > \left[\frac{F_2}{F_1}\right]^{\sigma-1}\left[\frac{w}{w+\nu f_1}\right]^{\sigma-1}\left[\frac{1}{\tau_1}\right]^{\sigma}$ so that $\frac{\underline{\varphi}_1}{\underline{\varphi}_2} > 1$.

[8] Where $\underline{\tilde{\varphi}}_2$ is the export threshold for manufacturers exporting to country 2. Similar to equation 3.6b, $\underline{\tilde{\varphi}}_2 = \left[\frac{w+\nu f_2}{\sigma-1}\right]\left[\frac{w\tilde{F}_2}{\mathrm{L}_2}\right]^{\frac{1}{\sigma-1}}\left[\frac{\sigma\tau_2}{p_o}\right]^{\frac{\sigma}{\sigma-1}}$. $\tilde{F}_2$ is the fixed overhead cost incur by manufactures exporting to country 2.

working in the same direction: an intensive effect, reinforced by the extensive effect of cargo pricing.[9] As derived in equation (3.8) the intensive effect is equal to the price elasticity of demand weighted by the relative importance of shipping costs in an exporter marginal cost. This is the result obtained by Hummels, Lugovskyy, and Skiba (2009). But in a model where firm heterogeneity determines the per unit shipping weight content of a good, the price elasticity of cargo has a second component derived from the effect of shipping prices on the extensive margin of trade because the export threshold condition (equation 3.6b) shifts with changes in shipping prices. Disregarding the product heterogeneity in the per unit weight content of goods implies that the model will underestimate the price elasticity of cargo, as the price elasticity of cargo will be equal to the intensive effect.

$$\xi_{f_1} = \underbrace{-\sigma \frac{\nu f_1}{w + \nu f_1}}_{\text{intensive}} - \underbrace{\frac{\underline{\varphi}_1{}^{\sigma}}{\int_{\underline{\varphi}_1}^{\infty} \varphi^{\sigma-1} \mathrm{d}G(\varphi)} \times g(\underline{\varphi}_1) \frac{\nu f_1}{w + \nu f_1}}_{\text{extensive}} \tag{3.8}$$

As in Melitz (2003), manufacturers draw their productivity level from a distribution function that is Pareto distributed with a cumulative distribution $G(\varphi)$ equal to $1 - \frac{1}{\kappa}\varphi^{-\kappa}$: $\varphi \in [\underline{b}, \infty)$, and shape parameter $\kappa > 2$. Three technicalities should be taken into account: First, $\underline{b} = \kappa^{-\kappa}$. Second, setting κ greater than 2 guarantees a well defined second moment of φ. Third, given the consumer preferences and the distribution function on φ, the price elasticity of demand should be defined as a value on the interval $(1, \kappa + 1)$, thus $\kappa + 1 > \sigma$. Under these assumptions, I find that the price elasticity of cargo shipping is

$$\xi_{f_1} = -(\kappa + 1) \frac{\nu f_1}{w + \nu f_1}. \tag{3.9}$$

The price elasticity of cargo demand depends on the shape parameter of the distribution function determining productivity, weighted by the relative importance of the per unit freight cost in an exporter's marginal total cost. As in

[9] Appendix A provides a complete derivation of this expression.

Hummels, Lugovskyy, and Skiba (2009), this result relies on the concept that transportation is a service that arises from the demand of imported products. However, my result implies a higher response of cargo demand as $\kappa + 1 > \sigma$. I obtain this result based on two assumptions: First, a carrier sets shipping prices by the unit of weight of a product; i.e., dollars per kilogram, instead of setting cargo prices per unit of exported goods. Second, the weight component of a good is determined by a manufacturer's productivity draw. These two assumptions enable me to obtain that the price elasticity of cargo shipping depends on the dispersion of the productivity distribution function instead of the price elasticity of demand. When $\frac{\nu f_1}{w+\nu f_1}$ is small, cargo carriers may raise prices at the margin as the increase in shipping prices has a low effect on cargo demand. I use this elasticity to solve for the optimal pricing rule of air cargo carriers.

3.2.4 Air Cargo Carriers

Cournot competition in air cargo shipping implies that a carrier must decide on the optimal cargo weight W_j^n transported to markets 1 and 2, given the total weight choice of other competing carriers, and the cargo demand function derived in equations (3.7a) and (3.7b).

A carrier's total cost structure is determined by the workforce required to transport cargo, an airport specific cargo handling fee, the jet fuel[10] used to lift the cargo load throughout d_j miles of cargo haul, and the fixed overhead cost wF^a. A carrier's optimization problem is

[10]I assume that jet fuel is produced by competitive firms requiring $\frac{1}{\theta_g}$ workers to produce a gallon of jet fuel. Therefore, the optimal jet fuel price is $\frac{w}{\theta_g}$.

$$\max_{W_1^n, W_2^n} \Pi^n = \max_{W_1^n, W_2^n} \sum_{j=1}^{2} \left[f_j - w \left(\frac{1}{\theta} + \frac{1}{\varepsilon_1} + \frac{1}{\varepsilon_2} + \frac{d_j \alpha_g}{\theta_g} \right) \right] W_j^n - wF^a, \tag{3.10a}$$

$$\text{where:} \quad W_j^n = \frac{W_j}{\mathrm{N}^c} \quad \forall \quad j = 1, 2, \tag{3.10b}$$

$$W_1 = \nu \mathrm{L}_1 \left[\frac{p_o (\sigma - 1)}{\sigma \tau_1 (w + \nu f_1)} \right]^{\sigma} \int_{\underline{\varphi}_1}^{\infty} \varphi^{\sigma - 1} \mathrm{d}G(\varphi) \quad \text{and} \tag{3.10c}$$

$$W_2 = \nu \mathrm{L}_2 \left[\frac{p_o (\sigma - 1)}{\sigma \tau_2 (w + \nu f_2)} \right]^{\sigma} \int_{\underline{\tilde{\varphi}}_2}^{\infty} \varphi^{\sigma - 1} \mathrm{d}G(\varphi). \tag{3.10d}$$

$\frac{1}{\theta}$ is the labor content of a unit of transported cargo. $\frac{1}{\varepsilon_j}$ is the labor content of a unit of cargo weight handled by an airport in country j. The additive structure of the handling components implies that a carrier pays a handling fee of $\frac{w}{\varepsilon_j}$ for every unit of weight of cargo handled by airport entities at both the departing and arriving locations. $d_j \alpha_g W_j^n$ is the jet fuel required to lift W_j^n pounds of cargo through the effective air-born distance d_j,[11] where α_g is the gallon per weight-distance lift factor of jet fuel. Altogether, I assumed that a carrier's marginal cost is constant, and is determined by the following three components: the price of labor, the fees payed to airport entities at both the departing and arriving locations, and the jet fuel costs. First order conditions imply that a carrier's marginal revenue is equal to it's marginal costs wB_j

$$f_j \left[1 + \frac{1}{\mathrm{N}^c \xi_{f_j}} \right] = w \underbrace{\left[\frac{1}{\theta} + \frac{1}{\varepsilon_1} + \frac{1}{\varepsilon_2} + \frac{d_j \alpha_g}{\theta_g} \right]}_{B_j} \qquad \forall \quad j = 1, 2 \quad , \quad \forall \quad \mathrm{N}^c. \tag{3.11}$$

The former determined by the price elasticity of cargo shipping, and the latter determined by the per unit of weight cost of handling cargo by the carrier, the per

[11]Following Mattingly, Heiser, and Pratt (2005), I assume that air-born distance traveled by a carrier when incoming and outgoing from a destination is asymmetric. The argument relies on the evidence that air-born distance of a flight changes as the flight trajectory varies on: altitude, head wind or tail wind, the weather conditions and the air-traffic encountered during the flight, and within the lifting and landing phases of a flight. Provided that none of these factors are constant for both departing and returning flight legs, I assume that air-born distance is asymmetric.

unit weight cost of handling cargo by airports and the per unit weight cost of fuel. Substituting equation (3.9) into equation (3.11) I find that the shipping price per unit of weight is a function of the labor productivity of cargo carriers (θ), the labor productivity of cargo handling at both the departing and arrival airports (ξ_2, ξ_1), the effective air-born distance traveled (d_j), the number of competing carriers per cargo route (N^c), and the shape parameter of the productivity distribution function (κ)

$$f_j = \frac{(\kappa+1)\, wB_j + \frac{w}{\nu \mathrm{N}^c}}{\kappa + 1 - \frac{1}{\mathrm{N}^c}} \qquad \forall \quad j = 1,2 \quad , \quad \forall \quad \mathrm{N}^c. \tag{3.12}$$

Per unit of weight, shipping prices for all imported (exported) products are the same (equation 3.12). The difference in shipping prices between imported and exported products is determined by the difference in fuel expenditure $\alpha_g \frac{w}{\theta_g}\left[d_1 - d_2\right]$ amplified by term B_3 (equation (3.13)) which under Cournot competition is greater than 1

$$f_1 - f_2 = \alpha_g \frac{w}{\theta_g}\left[d_1 - d_2\right] \underbrace{\left[\frac{\kappa+1}{\kappa + 1 - \frac{1}{\mathrm{N}^c}}\right]}_{B_3}. \tag{3.13}$$

Since the jet fuel price is the same across markets, the difference in air shipping prices is mainly due to the assumption that air-born distance is asymmetric. If $d_1 = d_2$, air shipping prices for imported and exporter cargo will be the same.

Competition in air cargo shipping plays a key role in determining air shipping prices. As implied by equation (3.12), carriers set shipping prices that exhibit a markup that varies with the number of competing carriers. A shock to any of the fundamentals determining competition in air cargo shipping affects the markup of shipping prices through its impact on N^c. By construction, the endogenous response of the number of competitors is expected not only to impact air shipping prices, but also manufacturing firms, as entry into exporting and optimal delivery prices depend on the number of competing carriers.

My result nests the competitive outcome; i.e., when $\mathrm{N}^c \to \infty$ shipping prices decrease, converging to the marginal costs of air cargo shipping as $f_j = wB_j \quad \forall \quad j=1,2$. Furthermore, as $\mathrm{N}^c \rightarrow \infty$ the price difference in air shipping derived in equation (3.13) will decrease, and in the limit the price difference in air cargo shipping is only determined by the difference in fuel expenditure (as B_3 is equal to one); i.e., given by the difference in the distance traveled

$$f_1 - f_2 = \alpha_g \frac{w}{\theta_g} \left[d_1 - d_2 \right]. \tag{3.14}$$

Number of Cargo Carriers

Cournot competition with fixed entry costs into air cargo shipping implies that the optimal number of cargo carriers per cargo route is an endogenous variable that I can pin down using a carrier's zero profit condition (setting equation (3.10a) equal to zero). Unfortunately, the nonlinear functional form implied by this problem does not allow me to find a closed form solution for N^c. Instead, I use a carrier's zero profit condition to define function NC, which I then use to determine the fundamentals affecting entry into air cargo shipping. NC is a continuously differentiable convex function in N^c with the following functional form:[12]

$$\mathrm{NC} = \mathrm{N}^{c\,\frac{\kappa+2}{\kappa}} \underbrace{\left[\frac{w^{\frac{\kappa+1-\sigma}{\kappa(\sigma-1)}}}{\kappa+1} \right] \left[\frac{F^a}{(\mathrm{H}_1 + \mathrm{H}_2)\,\mathrm{H}_{\sigma\kappa}} \right]^{\frac{1}{\kappa}}}_{\mathrm{H}_3} - \mathrm{N}^c + \frac{1}{\kappa+1}. \tag{3.15}$$

H_3 is a positive constant determined by constants H_1, H_2 and $\mathrm{H}_{\sigma\kappa}$.[13] Under the additional assumption that $\mathrm{NC}(1) < 0$,[14] I find that solution for the optimal number of cargo carriers N^{c*} is unique. Figure 3.2(a) provides the graphical representation of this scenario as I set σ, κ and H_3 to take the values 1.52, 4 and .4358. Graphi-

[12] Appendix B provides a complete characterization of function NC.

[13] $\mathrm{H}_{\sigma\kappa} = \frac{(\sigma-1)^{\kappa+1}}{(\kappa+1-\sigma)(1+\kappa)^{\kappa+1}\sigma^{\frac{\sigma\kappa}{\sigma-1}}}$ and $\mathrm{H}_j = \frac{1+\nu \mathrm{B}_j}{(w+\nu \mathrm{B}_j)^{\kappa+1}} \left[\frac{\mathrm{L}_j^{\kappa} p_o^{\kappa\sigma}}{\tau_j^{\sigma\kappa} F_j^{\kappa+1-\sigma}} \right]^{\frac{1}{\sigma-1}} \quad \forall \quad j=1,2.$

[14] This condition enables me to rule out the cases where there is no equilibrium, or when the equilibria is characterized by two solutions.

cally, a solution for the optimal number of air carriers is provided when NC is equal to zero. In this particular case, the optimal number of cargo carriers is 4.84.[15]

As implied by H_1, H_2 and $H_{\sigma\kappa}$, the optimal number of cargo carriers N^c (equation (3.16)) is determined by the following four factors: *i*) Wages (w) and Jet fuel costs ($\frac{w}{\theta_g}$); *ii*)Product Specific Determinants: Price elasticity of demand (σ), average per unit weight content (ν) and product import tariffs (τ_j); *iii*) Route specific determinants: Market Size (L_j), Effective air-born distance (d_j), Infrastructure of Airports (ξ_j), Fixed overhead cost of exporting (F_j) and the fixed entry costs into air cargo (F^a) and; *iv*) The dispersion of the productivity distribution function (κ). Henceforth, I refer to these variables as the fundamentals.[16]

$$N^c = \mathfrak{F}\left(w, \sigma, \nu, \vec{\tau}, \vec{L}, \vec{d}, \theta, \theta_g, \vec{\xi}, \vec{F}, F^a, \kappa\right) \tag{3.16}$$

Column one in table 3.1 summarizes the sign of the effect of a shock to a fundamental on the number of competing carriers. Applying the implicit function theorem to function NC I obtain that $\dfrac{\partial N^c}{\partial x} = -\frac{\partial NC}{\partial x} / \frac{\partial NC}{\partial N^c}$. Since $NC(1) < 0$, $\frac{\partial NC}{\partial N^c}$ is always positive since we are always on the increasing part of function NC. Then, the overall effect on competition in due to the sign obtained for $\frac{\partial NC}{\partial x}$.

An increase in wages, fuel charges, import tariffs, effective air-born distance, fixed overhead costs of exporting or entry costs into cargo shipping decrease competition.[17] Graphically, this is consistent with an increase in the magnitude of H_3, which is associated with an increase in the convexity of NC. Figure 3.2(b) provides the graphical representation of the backward displacement of the NC function. In all cases, NC shifts from the initial position (blue line), to the new situation (red line), producing a decrease in the optimal number of cargo carriers.[18] Similarly, an increase in market size, airport infrastructure or an increase in a carrier's pro-

[15] At 0.257 (the first case), a carrier's optimal profit function will be negative, implying that the first case is not a feasible equilibrium.

[16] Vector representation implies that the variable is associated to both exporting and importing countries.

[17] In these cases $\frac{\partial NC}{\partial x} > 0$.

[18] I increase H_3 from 0.4358 (blue line) up to 0.4951 (red line).

ductivity level decreases the convexity of NC.[19] Graphically, the function shifts forward, producing an increase in the optimal number of cargo competitors. As shown, NC shifts from the initial position (blue line), to the new situation (black line).[20]

3.2.5 Equilibrium

Since the optimal number of carriers is given by equation (3.16), a manufacturer's optimal pricing rule, optimal total demand and optimal total revenue are

$$p_{\varphi j} = \left[\frac{\sigma}{\sigma-1}\right] \underbrace{\left[\frac{(\kappa+1)\left(1+\nu \mathrm{B}_j\right)}{\kappa+1-\frac{1}{\mathrm{N}^c}}\right]}_{\mathrm{CA}_j} \left[\frac{w\tau_j}{\varphi}\right] \quad , \tag{3.17a}$$

$$q_{\varphi j} = \left[\frac{\sigma-1}{\sigma}\right]^{\sigma} \left[\frac{\varphi}{w\tau_j}\right]^{\sigma} \mathrm{L}_j \left[\frac{1}{\mathrm{CA}_j}\right]^{\sigma} \quad \text{and} \tag{3.17b}$$

$$r_{\varphi j} = \left[\frac{\sigma-1}{\sigma}\right]^{\sigma-1} \left[\frac{\varphi}{w}\right]^{\sigma-1} \mathrm{L}_j \left[\frac{1}{\mathrm{CA}_j}\right]^{\sigma-1} \left[\frac{1}{\tau_j}\right]^{\sigma} \qquad \forall \quad j=1,2. \tag{3.17c}$$

The number of exporting manufacturing firms (M_j) and the total value of exports (IMP_j) realized by manufacturers exporting to countries 1 and 2 are

$$\mathrm{M}_1 = \psi^2 \left[1 - G(\underline{\varphi}_1)\right] = \frac{\psi^2}{\kappa} \underline{\varphi}_1^{-\kappa} \quad , \quad \mathrm{M}_2 = \psi^1 \left[1 - G(\underline{\tilde{\varphi}}_2)\right] = \frac{\psi^1}{\kappa} \underline{\tilde{\varphi}}_2^{-\kappa}, \tag{3.18a}$$

$$\mathrm{IMP}_1 = \underbrace{\left[\frac{\sigma-1}{\sigma w}\right]^{\sigma-1} \left[\frac{\mathrm{L}_1}{\tau_1^{\sigma}}\right] \left[\frac{1}{\mathrm{CA}_1}\right]^{\sigma-1}}_{\mathrm{IM}_1} \underbrace{\left[\frac{1}{\kappa+1-\sigma}\right] \left[\frac{1}{\underline{\varphi}_1}\right]^{\kappa+1-\sigma}}_{\mathrm{EM}_1} \quad \text{and} \tag{3.18b}$$

$$\mathrm{IMP}_2 = \underbrace{\left[\frac{\sigma-1}{\sigma w}\right]^{\sigma-1} \left[\frac{\mathrm{L}_2}{\tau_2^{\sigma}}\right] \left[\frac{1}{\mathrm{CA}_2}\right]^{\sigma-1}}_{\mathrm{IM}_2} \underbrace{\left[\frac{1}{\kappa+1-\sigma}\right] \left[\frac{1}{\underline{\tilde{\varphi}}_2}\right]^{\kappa+1-\sigma}}_{\mathrm{EM}_2} . \tag{3.18c}$$

---

[19]In these cases, $\frac{\partial \mathrm{NC}}{\partial x} < 0$.

[20]In this case, I decrease H_3 from 0.4358 (blue line) up to 0.3938 (black line).

ψ^j is the mass of domestic firms in country $j \quad \forall \quad j = 1,2$. IM_j and $\text{EM}_j \quad \forall \quad j = 1,2$ are the intensive and extensive margins of trade. $\underline{\varphi}_1$ and $\underline{\tilde{\varphi}}_2$ are the optimal export thresholds when exporting to markets one and two.[21]

$$\underline{\varphi}_1 = \left[\frac{\sigma^{\frac{\sigma}{\sigma-1}}}{\sigma-1}\right]\left[\frac{F_1\,(w\tau_1)^{\sigma}}{\text{L}_1}\right]^{\frac{1}{\sigma-1}} \text{CA}_1 \quad \text{and} \tag{3.19a}$$

$$\underline{\tilde{\varphi}}_2 = \left[\frac{\sigma^{\frac{\sigma}{\sigma-1}}}{\sigma-1}\right]\left[\frac{F_2\,(w\tau_2)^{\sigma}}{\text{L}_2}\right]^{\frac{1}{\sigma-1}} \text{CA}_2. \tag{3.19b}$$

Four considerations should be taken into account: First, equations (3.17a) through (3.19b) nest the results on pricing, total demand, entry into exporting and total volume of exports as originally derived by the Melitz (2003) model of trade. The difference between the two models is only due to the competitive adjustment factor CA_j. Setting $\text{B}_j = 0$ and assuming that the market structure in air cargo shipping is competitive ($\text{N}^c \to \infty$), CA_j will be equal to unity and equations (3.17a) through (3.19b) will simplify back to the standard Melitz (2003) results.

Second, highly productive manufacturers set lower optimal import prices. The latter is not only provided because highly productive manufacturers exhibit lower marginal production costs, but also because highly productive manufacturers are able to produce goods with lower per unit weight content implying lower per unit transportation charges.[22]

Third, I derived an alternative setup in which a manufacturer's optimal product price exhibits an endogenous markup. Previously Ottaviano, Tabuchi, and Thisse (2002) and Melitz and Ottaviano (2008) found that when consumers exhibit linear demand functions with horizontal product differentiation, product prices exhibit an endogenous markup as they also depend on the fixed entry sunk costs of exporting. Alternatively, I also obtain that a manufacturer's optimal pricing rule has an endogenous markup. But, endogenous markups arise when I endogenize air shipping costs by introducing a sector characterized by carriers

[21] $\underline{\tilde{\varphi}}_2$ was previously derived in footnote 8.

[22] A product's per unit shipping cost is given by the product of the optimal shipping price (equation 3.12) and a product's weight content $\frac{\nu}{\varphi}$.

competing in an oligopolistic market structure à la Cournot with fixed entry costs.

As derived in equation (3.17a), a manufacturer's markup is determined by the product of two terms: the constant markup derived in Melitz (2003), and term CA_j. The latter being the parameter through which endogeneity arises, as CA_j also depends on the optimal number of cargo carriers. Thus, a manufacturer's markup is endogenous to the fundamentals determining entry into air cargo shipping. The markup does not only vary with the fixed entry costs in the exporting destination (as in Melitz and Ottaviano (2008)), but it also varies with fixed entry costs into air cargo shipping and with factors associated to the market where the exporting manufacturer is located (e.g. local market size (see equation (3.16))). I reconcile this result with the more general claim that a manufacturer's optimal price exhibits an endogenous markup that varies with the fundamentals, determining entry to both export markets, and entry into air cargo shipping.

Fourth, this model provides optimal per unit product prices and optimal export entry conditions higher by a magnitude CA_j than the value obtained in the standard Melitz (2003) model. Thus, a country's total volume of exports is lower because both the intensive and extensive margins of trade are lower than the levels achieved in the standard set up. The intensive margin is lower because manufacturers are setting optimal pricing rules at higher levels, causing demand and revenue to fall. The extensive margin is lower because the entry condition into exporting is set at a higher level, making entry into exporting a more difficult situation as manufacturers now require a higher productivity draw to be able to enter into foreign markets.

3.2.6 Comparative Statics

In this sub-section I provide a detailed derivation of the effect of a shock to a fundamental on prices, total demand, a manufacturer's revenue, the export threshold condition, and the total volume of trade.[23] First, I derive the effect of a shock to a fundamental on the air shipping price per unit of weight and on a

[23] Appendix C provides a complete derivation of these results.

manufacturer's product price. This not only enables me to relate my findings to the results implied by the standard Melitz (2003) model, but it also enables me to show the additional effects that arise when I let transport prices be set by carriers competing à la Cournot with fixed entry costs into air cargo. Second, I use the change in prices to derive the comparative statics on demand, a firm's optimal revenue, and on a country's volume of exports. Tables 3.1 and 3.2 provide the complete summary of the comparative statics derived on prices, demand, revenue and total volume of trade. $-$ and $+$ corresponds to the sign of the effect, while 0 means no effect.

Without loss of generality, the optimal shipping price (equation (3.12)) and a manufacturer's product price (equation 3.4b) can be re-expressed as

$$f_j(\vec{x}, \mathrm{N}^c(\vec{x})) \quad \text{and} \quad p_{\varphi j}(\vec{x}, f_j(\vec{x}, \mathrm{N}^c(\vec{x}))). \tag{3.20}$$

$\vec{x}$ is the vector representation of the exogenous factors of the model;i.e. the fundamentals. Let x be an exogenous factor in $\vec{x}$. A shock to an exogenous variable x may have a direct impact on prices, but it also has an indirect effect canalized through the endogenous reaction of the number of cargo carriers. The latter reaction is what I refer to as the competitive channel. In this model, the net effect of a shock to any fundamental on prices, demand, a manufacturer's revenue and a country's volume of exports is equal to the effect of the shock transmitted through the direct and the competitive channels. As reported in table 3.1, the net effect might be equal to $-$, $+$, $--$ or $++$. $-$ and $+$ implies that the net effect is derived by the transmission of the shock through the competitive channel. $--$ and $++$ imply that the net effect of the shock on air shipping prices is the result of adding the effect canalized through the the direct and the competitive channels; both working in the same direction. Then, the effect of a shock to x on air shipping prices is

$$\frac{\mathrm{d}f_j}{\mathrm{d}x} = \left[\frac{f_j}{x}\right]\left[\tilde{\delta}_{f_j,x} + \delta_{f_j,\mathrm{N}^c}\delta_{\mathrm{N}^c,x}\right]. \tag{3.21}$$

$\tilde{\delta}_{f_j,x} = \frac{\partial f_j}{\partial x}\frac{x}{f_j}$ is the direct effect of the change in x on air shipping prices, while the competitive effect of a change in x is determined by the product of the following two components: the effect of a change in the number of cargo carriers on shipping prices $\delta_{f_j,\mathrm{N}^c} = \frac{\partial f_j}{\partial \mathrm{N}^c}\frac{\mathrm{N}^c}{f_j}$, and the effect of a change in x on the optimal number of cargo carriers $\delta_{\mathrm{N}^c,x} = \frac{\partial \mathrm{N}^c}{\partial x}\frac{x}{\mathrm{N}^c}$. As implied by equation (3.12) $\delta_{f_j,\mathrm{N}^c} = -\left[\frac{1}{\mathrm{N}^c} + \frac{w}{\nu f_j \mathrm{N}^c}\right]$, while $\delta_{\mathrm{N}^c,x}$ is derived by using the implicit function theorem on equation (3.15). The negative sign on $\delta_{f_j,\mathrm{N}^c}$ guarantees that a shock deterring competition will always imply a net positive effect on air shipping prices. Furthermore, this is the reason why when $\tilde{\delta}_{f_j,x} \neq 0$, both the direct and the competitive channels reinforce each other.

Results in table 3.1 show that $\frac{\mathrm{d} f_j}{\mathrm{d} x}$ is never equal to zero. Even when $\tilde{\delta}_{f_j,x} = 0$, the shock has an still effect on air shipping prices through the adjustment in the number of competitor cargo carriers. I find that a shock to the fixed entry costs into exporting, the fixed entry cost into air cargo shipping, import tariffs in the origin market or a shock to market size impacts air shipping prices only through the competitive channel. In all the others cases, the shock affects air shipping prices through both the direct and competitive channels.

Understanding the adjustment of air shipping prices enables me to infer that the effect of the shock on a manufacturer's product price is

$$\frac{\mathrm{d} p_{\varphi j}}{\mathrm{d} x} = \left[\frac{p_{\varphi j}}{x}\right]\left[\tilde{\delta}_{p_{\varphi j},x} + \mathrm{S}_{f_j}\left(\frac{\mathrm{d} f_j}{\mathrm{d} x}\frac{x}{f_j}\right)\right]. \quad \text{Implying} \tag{3.22}$$

$$\frac{\mathrm{d} p_{\varphi j}}{\mathrm{d} x} = \left[\frac{\sigma}{\sigma - 1}\right]\left[\frac{w + \nu f_j}{\varphi x}\right]\left[\underbrace{\tilde{\delta}_{p_{\varphi j},x}}_{1} + \underbrace{\mathrm{S}_{f_j}\tilde{\delta}_{f_j,x}}_{2} + \underbrace{\mathrm{S}_{f_j}\delta_{f_j,\mathrm{N}^c}\delta_{\mathrm{N}^c,x}}_{3}\right]. \tag{3.23}$$

$\tilde{\delta}_{p_{\varphi j},x} = \frac{\partial p_{\varphi j}}{\partial x}\frac{x}{p_{\varphi j}}$ is the direct effect of the change in x on a manufacturer's marginal cost. S_{f_j} is the relative importance of the per unit freight cost in a manufacturer's optimal price; i.e. $\frac{v f_j}{w + v f_j}$. In equation (3.23) terms 2 and 3 correspond to the endogenous response of air shipping prices weighted by the relative importance of freight charges on a manufacturer's marginal cost. In comparison to the standard Melitz model, the comparative statics that I derive are higher in magnitude because of two reasons: First, as implied by equation 3.4a, a shock to a fundamental has three effects; a direct effect on a manufacturer's optimal price, a direct effect on the optimal per unit of weight cargo price f_j and an a third effect arising from the endogenous reaction of competition in air cargo (term 3). It is the competition adjustment in air cargo shipping that explains why manufacturing companies adjust their optimal pricing rule even when the shock is only related to the entry conditions in the air cargo industry; e.g., a shock to the fixed entry cost into cargo (F^a). In this case, terms 1 and 2 would be zero, and all of the price adjustment is given by the endogenous response to the number of cargo carriers (term 3). Second, in the cases where the shock implies that terms 1, 2 and 3 are all different from zero (e.g. a shock to wages), a manufacturer's price adjustment is greater than the adjustment suggested by the models assuming iceberg transport costs. As derived, terms 1 and 2 always have the same sign, while the interaction between $\delta_{f_j,\mathrm{N}^c}$ and $\delta_{\mathrm{N}^c,x}$ guarantees that term 3 always has the same sign too.

Similarly, comparative statics on total demand and on a manufacturer's revenue are:

$$\frac{\mathrm{d}q_{\varphi j}}{\mathrm{d}x} = \left[\frac{q_{\varphi j}}{x}\right]\left[\tilde{\delta}_{q_{\varphi j},x} - \sigma\left[\tilde{\delta}_{p_{\varphi j},x} + \mathrm{S}_{f_j}\left(\frac{\mathrm{d}f_j}{\mathrm{d}x}\,\frac{x}{f_j}\right)\right]\right] \quad \text{and} \tag{3.24}$$

$$\frac{\mathrm{d}r_{\varphi j}}{\mathrm{d}x} = \left[\frac{r_{\varphi j}}{x}\right]\left[\tilde{\delta}_{q_{\varphi j},x} - (\sigma-1)\left[\tilde{\delta}_{p_{\varphi j},x} + \mathrm{S}_{f_j}\left(\frac{\mathrm{d}f_j}{\mathrm{d}x}\,\frac{x}{f_j}\right)\right]\right]. \quad \text{Substituting,} \tag{3.25}$$

equation (3.21) into equations (3.24) and (3.25) I obtain that the comparative statics for demand and revenue are also higher in magnitude than the effect obtained when shipping costs are exogenous (terms 2 and 3 are equal to zero):

$$\frac{\mathrm{d}q_{\varphi j}}{\mathrm{d}x} = \left[\frac{\tau_j^{\sigma}}{x}\right]\left[\frac{(\sigma-1)\,\varphi}{\sigma\left(w+\nu f_j\right)}\right]^{\sigma}\left[\underbrace{\tilde{\delta}_{q_{\varphi j},x}}_{4} - \sigma\left(\underbrace{\tilde{\delta}_{p_{\varphi j},x}}_{1} - \underbrace{\mathrm{S}_{f_j}\tilde{\delta}_{f_j,x}}_{2} - \underbrace{\mathrm{S}_{f_j}\delta_{f_j,\mathrm{N}^c}\delta_{\mathrm{N}^c,x}}_{3}\right)\right] \tag{3.26}$$

$$\frac{\mathrm{d}r_{\varphi j}}{\mathrm{d}x} = \left[\frac{\tau_j^{-\sigma}}{x}\right]\left[\frac{(\sigma-1)\,\varphi}{\sigma\left(w+\nu f_j\right)}\right]^{\sigma-1} \times \tag{3.27}$$

$$\left[\underbrace{\tilde{\delta}_{q_{\varphi j},x}}_{4} - (\sigma-1)\left(\underbrace{\tilde{\delta}_{p_{\varphi j},x}}_{1} + \underbrace{\mathrm{S}_{f_j}\tilde{\delta}_{f_j,x}}_{2} + \underbrace{\mathrm{S}_{f_j}\delta_{f_j,\mathrm{N}^c}\delta_{\mathrm{N}^c,x}}_{3}\right)\right].$$

Interestingly, a shock affects manufacturers differently as most productive exporters are the ones who experience the higher adjustment in demand, implying a higher response in revenue too.

Table 3.2 summarizes the results derived on the export entry threshold, the extensive and intensive margins of trade. Without loss of generality I only derive the comparative statics for foreign country 2 (IMP_1). The endogenous response implied by the competitive effect in air cargo captured by the interaction of terms $\delta_{\underline{\varphi}_1,\mathrm{N}^c}$ and $\delta_{\mathrm{N}^c,x}$ implies that the export entry condition has a higher response to shocks as

$$\frac{\mathrm{d}\underline{\varphi}_1}{\mathrm{d}x} = \frac{\underline{\varphi}_1}{x}\left[\tilde{\delta}_{\underline{\varphi}_1,x} + \delta_{\underline{\varphi}_1,\mathrm{N}^c}\delta_{\mathrm{N}^c,x}\right]. \tag{3.28}$$

Since $\delta_{\underline{\varphi}_1,\mathrm{N}^c} = -\frac{1}{(\kappa+1)\mathrm{N}^c-1}$, the threshold change depends on the effect of the shock on the number of cargo carriers.

$$\frac{\mathrm{d}\underline{\varphi}_1}{\mathrm{d}x} = \frac{\underline{\varphi}_1}{x}\left[\tilde{\delta}_{\underline{\varphi}_1,x} - \frac{\delta_{\mathrm{N}^c,x}}{(\kappa+1)\,\mathrm{N}^c - 1}\right]. \tag{3.29}$$

I find that factors deterring competition in air cargo are also linked, causing a decrease in the number of exporting manufacturers because a decrease of competition in air cargo causes the export entry threshold to increase.

I use equation 3.18a to derive the net effect on the total volume of exports of country 2. The first two terms in the bracket derived in equation 3.30 correspond to the effect of a shock on the intensive margin, while the third term corresponds to the net effect of the shock on the extensive margin.

$$\frac{\mathrm{dIMP}_1}{\mathrm{d}x} = \frac{\mathrm{IM}_1\mathrm{EM}_1}{x}\left[\tilde{\delta}_{\mathrm{IM}_1,x} + \delta_{\mathrm{IM}_1,\mathrm{N}^c}\delta_{\mathrm{N}^c,x} + \delta_{\mathrm{EM}_1,\underline{\varphi}_1}\left(\frac{\mathrm{d}\underline{\varphi}_1}{\mathrm{d}x}\frac{x}{\underline{\varphi}_1}\right)\right] \tag{3.30}$$

Since $\delta_{\mathrm{IM}_1,\mathrm{N}^c} = \frac{\sigma-1}{\mathrm{N}^c(\kappa+1)-1}$ and $\delta_{\mathrm{EM}_1,\underline{\varphi}_1} = -\left(\kappa+1-\sigma\right)$ I substitute these two expressions and equation (3.29) into equation (3.30) and I obtain that the effect on the total volume of exports depends on the direct effect over the intensive margin, the export entry condition, and the direct effect of shock on the optimal number of cargo carriers

$$\frac{\mathrm{dIMP}_1}{\mathrm{d}x} = \frac{\mathrm{IM}_1\mathrm{EM}_1}{x}\left[\tilde{\delta}_{\mathrm{IM}_1,x} - \left(\kappa+1-\sigma\right)\tilde{\delta}_{\underline{\varphi}_1,x} + \left[\frac{\kappa}{\mathrm{N}^c\left(\kappa+1\right)-1}\right]\delta_{\mathrm{N}^c,x}\right]. \tag{3.31}$$

I find that an increase in the export threshold is accompanied by a decrease in the intensive and the extensive margins of trade. In all cases the channels reinforce each other, and the net effect on the total value of exports is the expected one.

Endogenizing air shipping costs assuming that cargo carriers compete à la Cournot with fixed entry costs into air cargo shipping enables me to derive a new set of results that the benchmark Melitz model of trade cannot capture, as it assumes that transport costs are exogenously given. The novelty of these results reside on the following three extensions: First, I showed that the comparative statics on a manufacturer's optimal price, demand, revenue and the total volume of exports are all higher in magnitude than the values obtained in the standard Melitz (2003) model. Second, as in Melitz and Ottaviano (2008), I find an alternative way to obtain optimal prices with endogenous markups. I find that a manufacturer's markup not only varies with the fixed entry cost into exporting, but also with the market conditions of the whole cargo route. Third, I show that omitting the adjustment canalized through the competition channel produces comparative statics that are lower in magnitude, underestimating the net effect of changes in the exogenous parameters of the model.

3.3 Empirics

In equation 3.12, I find that a carrier's air shipping price is given by a markup over marginal air shipping costs. A carrier's markup is determined by the number of carriers servicing a cargo route, and by a constant parameter that measures the dispersion of the distribution function determining productivity. A carrier's marginal shipping costs is determined by a carrier's productivity level, an airport's marginal handling cost, and the per kilogram cost of jet fuel. Estimating the precise functional form for air shipping prices is difficult since the solution requires nonlinear interactions between the levels of these variables, which in some cases I'm unable to measure exactly (i.e, an airline productivity level). Since I'm mainly interested in testing the effect of competition on cargo prices, I estimate several specifications all relying on the following reduced log-linear specification

$$\ln f_{\varphi jt} = \gamma + \beta_1 \ln n_{jt} + \beta_2 \ln \tilde{mc}_{jt} + \Lambda_J \mathrm{D}_J + \Lambda_T \mathrm{D}_T + \Lambda_\Omega \mathrm{D}_\Omega + \mu_{\varphi jt}. \tag{3.32}$$

$f_{\varphi jt}$ is the per kilogram air shipping price of a product exported from foreign country j at time t. n_{jt} is the number of competing carriers and $\tilde{mc}_{jt}$ is an airport's handling cargo cost given by the ratio between a country's wage w_{jt} and a country's airport productivity level ε_{jt}. A carrier's productivity level and the jet fuel consumption are route-specific characteristics that I choose to control with route (D_J) and year-specific fixed effects (D_T). The inclusion of route and year fixed effects enables me to control for non-observables correlated with the marginal costs of air cargo shipping. The route-specific component controls for economies of scale that are route-specific, while the time component controls for the economies of scale of cargo shipping that affect all carriers in the same way; e.g., an improvement in fuel consumption of airplanes. But, air shipping prices may also vary per product, as product characteristics may imply that special handling needs are required for international transportation. Therefore, all specifications include a set of product fixed effect (D_φ) which I use to control for non-observable product characteristics that affect the marginal cost structure of cargo carriers. In the model the dispersion of the distribution function (κ) is a constant parameter that I captured in all my specifications with the intercept. $\mu_{\varphi jt}$ is the orthogonal error component of per kilogram air cargo shipping prices.

In section 3.2, I assumed that there is only one type of air cargo shipping service, air shipping prices are not affected by the pricing performed by other modes of transportation,[24] and marginal costs of cargo shipping are constant. For robustness purposes I expand my basic specification and I test wheter the results on competition hold as I control for the competition arising from other transport modes, and as I control for shipping requirements not captured by the set of product fixed effects

$$\begin{aligned} \ln f_{\varphi jt} =& \gamma + \beta_1 \ln n_{jt} + \beta_2 \ln \tilde{mc}_{jt} + \beta_3 \ln vess_{\varphi jt} + \beta_4 \ln p_{\varphi it} + \\ & \Lambda_J D_J + \Lambda_T D_T + \Lambda_\Omega D_\Omega + \mu_{\varphi jt}. \end{aligned} \tag{3.33}$$

$vess_{\varphi j}$ is the per kilogram shipping cost when a product is transported by ocean mode, while $p_{\varphi i}$ corresponds to a product's price at factory gate[25] used to proxy for product specific handling costs not captured by the set of product fixed effects. The inclusion of a product's factory gate price is explained by the following two reasons: First, empirically transport costs are usually reported including the insurance component. Second, air shipping services are usually offered with a variety of additional service options offered at additional marginal costs; i.e., time to delivery and special cargo handling requirements. Thus, manufacturers exporting more valuable products pay a higher insurance (as insurance is calculated as a function of the product price), and valuable products are also expected to require

[24] Hummels (2007a) and Hummels (2007b) provide a first characterization relating the choice of transportation mode with the type of goods shipped across international destinations. Alternatively Hummels and Schaur (2010) find that a firm's choice of international shipping mode can be use as a mean of responding to favorable demand realizations. Thus, the choice of a particular transport mode enables a manufacturer to limit the risk of producing unprofitably large quantities in periods of low demand.

[25] refer to equation (3.4a)

more careful handling, increasing the marginal cost of cargo shipping.[26] Estimates on β_3 and β_4 are both expected to be positive.

In the model, route-specific economies of scale are all canalized through the competitive channel, as the optimal number of cargo carriers increases with the total scale of cargo. But it might be the case that shipment scales may affect a carrier's marginal cost as this may vary with the scale of operations. Empirically, this could lead to pricing rules depending on the size of the shipment, charging a higher rate for shipments below a certain weight threshold.[27] Similar to Hummels, Lugovskyy, and Skiba (2009), I compare the estimates obtained in equation (3.33) as I sort cargo by it's total weight content into 10 equally sized bins. Lack of variation on the reported coefficients will reflect the idea that economies of scale of the route do not represent a source of potential bias for my estimates.

The data used to estimate these specifications come from different sources. I used the U.S. Imports of Merchandize dataset to build an unbalanced panel with product level information (10 digit harmonized system code) on shipping costs, cargo weight, f.o.b. value of exports and factory gate prices of the products exported to the U.S market by transportation mode (ocean or air mode) for the period between 1990 and 2009.[28] Ideally, a cargo route should be defined by the airports where the cargo service is provided. But given that the transport costs data is only available at the country level, I define a cargo route by the origin country from which the product is exported from. I use the T-100 Data Bank, also known as the Air Carrier Statistics database, to obtain information of competition per cargo route. Competition is first measured as the count of cargo carriers that provide transportation of goods in fully cargo loaded flights departing from any country in the world to the US market. Second, I use the flight level information available in the data to construct a Herfindahl index per cargo route that I use as a robustness check on the validity of the sign of the effect of competition on air

[26] In Hummels, Lugovskyy, and Skiba (2009) optimal air cargo shipping prices are a function of a product's gate price. But this result is derived under the exogenous assumption that a carriers marginal cost is given by the following functional form $\exp^{\gamma_o} p_{\varphi}^{\gamma_1} dist^{\gamma_3}$.

[27] For example, Delta Cargo set's a per kilogram price threshold at 100 kgs.

[28] See Feenstra, Romalis, and Schott (2002) for a detail description of the information available in this data-set.

shipping prices.

A country's airport marginal cargo handling cost is a variable defined by the ratio between a country's wage and a country's airport productivity level. A country's wage is proxy by the GDP per capita extracted from the World Bank's World Development Indicators (WDI), while a country's airport productivity level is proxied with a country's average airport productivity level. Airport productivity estimates were obtained from the Global Airport Benchmarking Report produced by the Airport Transport Research Society (ATRS). Unfortunately, the country coverage of the estimates of airport productivity constrained me to only using information from 31 countries.[29]Altogether, I'm able to build a dataset of transport costs for 18,756 products exported from 31 countries to the U.S. market, for the period between 1990 and 2009. Figure 3.1 plots the number of cargo carriers operating between a given exporter and the US market. Consistent with the model, the number of carriers increases with the size of trade. Following the US Federal Trade Commission guidelines on market concentration,[30] summary statistics on the number of cargo carriers and the Herfindahl index in this data provides a first evidence that the assumption of oligopolistic competition in air cargo routes is valid, in the data the average cargo route is classified as a highly concentrade market (table 3.4).

3.3.1 Results

Table 3.5 reports the results of the effect of airport cargo handling fees and air cargo competition on air shipping prices. As expected air shipping prices are higher when transportation is performed through airports characterized by higher marginal cargo fees. Similarly, shipping prices decrease as competition in air cargo shipping increases. In all specifications, results are significant at 1%, and the magnitude of the estimated coefficients do not seem to vary as I control for product

[29]Table 3.3 provides a complete list of the countries included in the sample.

[30]According to the FTC, a Herfindhal Index (HHI) below 100 indicates that the market is highly competitive. When HHI is between 100 and 1,500, the FTC classifies the market as unconcentrated. When HHI is between 1,500 and 2,500 the FTC classifies the market as moderate concentrated, and when HHI is above 2,500 the FTC determines that the market is highly concentrated.

characteristics affecting the marginal handling costs of cargo shipping (column (2)), or as I also control for the competition arising from ocean transportation (column (3)). Results are also robust to the inclusion of the Herfindahl index, used as an alternative measure of competition in an air cargo route(column (4)).

The interaction between an airport's cargo handling cost and the degree of competition derived in equation 3.12 suggests that the effect on prices of an improvement in cargo handling costs or an increase in competition depends on the interaction term omitted in specifications 1 through 4. In column (5) I estimate equation 3.33, including the interaction term, and I find that the reduction in air shipping prices achieved by the reduction in an airport's handling charges is higher than the reduction achieved by air shipping prices due to a change in competition. Evaluated at sample means, a 10% decrease in a country's airport handling costs reduces air shipping prices by 3.58%, while a 10% increase in the degree of competition produces a 1% reduction in air shipping prices.

Although route and year fixed effects are expected to control for the economies of scale of cargo shipping, shipment scales might be at work as carriers are well known to charge prices depending on the overall shipping weight of a product. In table 3.6 I sorted the sample by a shipment's total cargo weight, and I organized cargo shipments into 10 equally sized bins. With this organization, I proceeded to test whether the coefficients derived from airport handling costs and competition in columns 3 and 4 in table 3.5 are similar in magnitude and significant across bins. Panel A reports the results obtained when competition is measured by the number of carriers, while panel B includes the estimates when the Herfindahl index is included as my measure of competition. As reported, the correlation of air shipping prices, airport handling charges and competition are not due to a scale effect. In both panels, the coefficients associated to airport handling charges and competition are robust in magnitude and they are all significant at 1%. Interestingly, in both panels the coefficient on ocean shipping costs increases as the weight of cargo increases. The monotonic relationship across cargo bins is explained because the competition for cargo between the two transport modes increases as shipments are characterized by higher weight content.

3.4 Conclusions

Recent literature on international trade has provided empirical evidence of the increasing role of transport costs as a component of trade deterrence. Understanding the underlying determinants of trade will help policy makers to implement policies to reduce transport costs, and help manufacturing firms become more integrated into the world market.

In this paper, I developed a firm heterogenous model of trade with endogenous air shipping costs. I introduced a transport sector characterized by carriers competing à la Cournot with fixed entry costs into air cargo shipping. As a result, I derived an optimal air shipping pricing rule determined by a varying markup and a constant cargo handling cost. The former determined by the number of cargo carriers, and the later determined by an airline's productivity level, airports cargo handling costs and fuel consumption. The endogenous response of the number of carriers enabled me to derived a general equilibrium model of trade that exhibits higher welfare effects due to the endogenous adjustment of competition in air cargo. I call this effect the competitive channel. To test the importance of the competitive channel, I take the model to the data and I use product level data of exports to the US market to test the relevance of competition in cargo shipping. I find that an increase in competition in air cargo is correlated with a significant reduction in air shipping prices. Results are robust to alternative measurements of competition, and they are also robust to the economies of scale present in air cargo shipping.

3.5 Bibliography

Anderson, J. E., and E. van Wincoop (2004): "Trade Costs," *Journal of Economic Literature*, 42(3), 691–751.

Clark, X., D. Dollar, and A. Micco (2004): "Port efficiency , maritime transport costs , and bilateral trade," *Journal of Development Economics*, 75(2), 417 – 450.

Feenstra, R., J. Romalis, and P. Schott (2002): "U.S. Imports, Exports and Tariff Data, 1989-2001," *NBER Working Paper Series.*, WP 9387, 1989–2001.

Hellermann, R. (2006): *Capacity Options for Revenue Management. Theory and Applications in the Air Cargo Industry.* Springer., Heidelberg, Germany., 1 edn.

Hummels, D. (2007a): "Transportation Costs and International Trade in the Second Era of Globalization," *Journal of Economic Perspectives*, 21(3), 131–154.

——— (2007b): "Transportation Costs and International Trade over Time," *Journal of Economic Perspectives*, 21(3), 131–154.

Hummels, D., V. Lugovskyy, and A. Skiba (2009): "The trade reducing effects of market power in international shipping," *Journal of Development Economics*, 89(1), 84–97.

Hummels, D., and G. Schaur (2010): "Hedging price volatility using fast transport," *Journal of International Economics*, 82(1), 15–25.

Limão, N., and A. J. Venables (2001): "Infrastructure , Geographical Disadvantage , Transport Costs , and Trade," *The World Bank Economic Review*, 15(3), 451–479.

Mas-Collel, A., M. Whinston, and J. Green (1995): *Microeconomic Theory.* Oxford University Press.

Mattingly, J., W. Heiser, and D. Pratt (2005): *Aircraft Engine Design.*, vol. 1. AIAAEducationn Series., 2 edn.

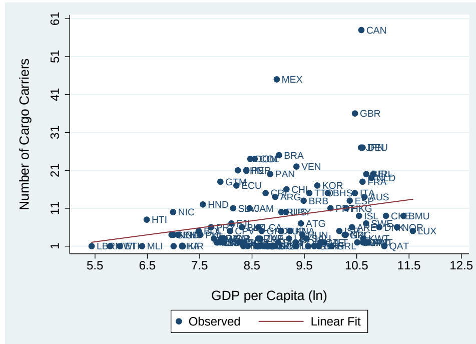
Melitz, M. (2003): "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity," *Econometrica*, 71(6), 1695–1725.

Melitz, M., and G. Ottaviano (2008): "Market Size , Trade , and Productivity," *The Review of Economic Studies*, 75(1), 295–316.

Micco, A., and T. Serebrisky (2006): "Competition regimes and air transport costs : The effects of open skies agreements," *Journal of International Economics*, 70(1), 25 – 51.

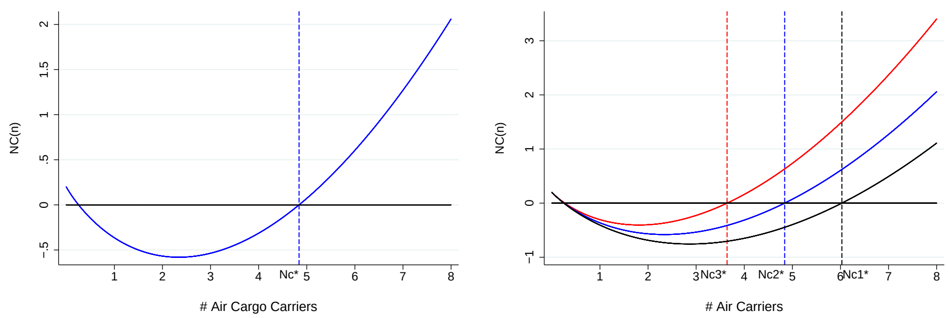
Ottaviano, G., T. Tabuchi, and J. Thisse (2002): "Agglomeration and Trade Revisited," *International Economic Review*, 43(2), 409–436.

Figures



Note: GDP per capita was obtained from the World Bank WDI(2009). The number of air carriers per route was obtained from the BTS T-100 Database(2009).

Figure 3.1: GDP per Capita (ln) vs. Number of Air Carriers, year 2009



(a) Optimal N_c^* (b) ΔF_{12}^c

Note: See Appendix B for a detailed derivation of function NC. In both figures I assume $\kappa = 4$ and $\sigma = 1.5$. Figure 3.2(a) provides a complete characterization of function NC as defined in equation 3.16. N^c corresponds to the optimal number of air carriers when $H_3 = 0.4358$. n^c equal 0.257 is not a solution because at this value a carrier's optimal profit function will be negative. In the second case N^{c*} is 4.84. Figure 3.2(b) characterizes the solutions as H_3 varies in magnitude. Nc1 Nc2 and Nc3 are the solutions obtained when H_3 is either 0.4951, 0.4358 or 0.3938.

Figure 3.2: Optimal Number of Air Cargo Carriers.

Tables

Table 3.1: **Comparative Statistics on the Number of Carriers, Per kg. Shipping Price, Product Import Price, Total Product Demand, and a Manufacturer's Total Revenue.**

Fundamentals	# of Carriers	Per kg. Shipping Price			Product Delivery Price			Product Demand			Total Revenue
	$\mathrm{d}\mathrm{N}^{c*}/\mathrm{d}x$	$\mathrm{d}f_1/\mathrm{d}x$			$\mathrm{d}p^c_{\varphi 1}/\mathrm{d}x$			$\mathrm{d}q_{\varphi 1}/\mathrm{d}x$			$\mathrm{d}r_{\varphi 1}/\mathrm{d}x$
	Net	**Direct**	**Comp.**	**Net**	**Direct**	**Comp.**	**Net**	**Direct**	**Comp.**	**Net**	**Net**
	(1)	(2)	(3)	(2)+(3)	(4)	(5)	(4)+(5)	(6)	(7)	(6)+(7)	(4)+(5)+(6)+(7)
Factor Related											
Wage (w)	-	+	+	++	+	+	++	-	-	- -	- -
Jet Fuel Cost ($w\frac{d_j\alpha_g}{\theta_g}$)	-	+	+	++	+	+	++	-	-	- -	- -
Air Carrier Productivity (θ)	+	-	-	- -	-	-	- -	+	+	++	++
Product Specific											
Import Tariff in Country 1 (τ_1)	-	0	+	+	+	+	++	-	-	- -	- -
Import Tariff in Country 2 (τ_2)	-	0	+	+	0	+	+	0	-	-	-
Price Elasticity of Demand (σ)	+	0	-	- -	-	-	- -	+	+	+ +	+ +
Route Specific											
Market Size in Country 1 (L_1)	+	0	-	-	0	-	-	+	+	+	+
Market Size in Country 2 (L_2)	+	0	-	-	0	-	-	0	+	+	+
Airport Productivity in Country 1 (ξ_1)	+	-	-	- -	-	-	- -	+	+	+ +	+ +
Airport Productivity in Country 2 (ξ_1)	+	-	-	- -	-	-	- -	+	+	+ +	+ +
Fixed Costs of Exporting to Country 1 (F_1)	-	0	+	+	0	+	+	0	-	-	-
Fixed Costs of Exporting to Country 2 (F_2)	-	0	+	+	0	+	+	0	-	-	-
Fixed Entry Costs into Air Cargo Shipping (F^a)	-	0	+	+	0	+	+	0	-	-	-
Manufacturer Specific											
Manufacturer Productivity Level (φ)	0	0	0	0	-	0	-	+	0	+	+

Column (1) is derived using the implicit function theorem on equation (3.15). Columns (2) and (3) correspond to terms $\tilde{\delta}_{f_j,x}$ and $\delta_{f_j,\mathrm{N}^c}\delta_{\mathrm{N}^c,x}$ derived in equation (3.21). Columns (3) and (4) correspond to terms $\tilde{\delta}_{p_{\varphi j},x} + \mathrm{S}_{f_j}\tilde{\delta}_{f_j,x}$ and $\mathrm{S}_{f_j}\delta_{f_j,\mathrm{N}^c}\delta_{\mathrm{N}^c,x}$ derived in equation (3.23). Columns (5) and (6) correspond to $\tilde{\delta}_{q_{\varphi j},x} - \sigma\left(\tilde{\delta}_{p_{varphij,x}} - \mathrm{S}_{f_j}\tilde{\delta}_{f_j,x}\right)$ and $\sigma\mathrm{S}_{f_j}\delta_{f_j,\mathrm{N}^c\delta_{\mathrm{N}^c,x}}$ derived in equation (3.26). The net effect on a manufacturer's revenue corresponds to equation (3.27).

Table 3.2: Comparative Statics on the Endogenous Export Entry Threshold, Extensive and Intensive Margins of Trade, and Total Value of Exports.

Fundamentals	Export Threshold			Extensive Margin			Intensive Margin			Total Exports
	$\mathrm{d}\underline{\varphi}_1$/x			$\mathrm{dEM}_1/\mathrm{d}x$			$\mathrm{dIM}_1/\mathrm{d}x$			$\mathrm{dIMP}_1/\mathrm{d}x$
	Direct	**Comp.**	**Net**	**Direct**	**Comp.**	**Net**	**Direct**	**Comp.**	**Net**	**Net**
	(1)	(2)	(2)+(3)	(4)	(5)	(4)+(5)	(6)	(7)	(6)+(7)	(4)+(5)+(6)+(7)
Factor Related										
Wage (w)	+	+	++	-	-	- -	-	-	- -	- -
Jet Fuel Cost ($w\frac{d_j\alpha_g}{\theta_g}$)	+	+	++	-	-	- -	-	-	- -	- -
Air Carrier Productivity (θ)	-	-	- -	+	+	++	+	+	++	++
Product Specific										
Import Tariff in Country 1 (τ_1)	+	+	++	-	-	- -	-	-	- -	- -
Import Tariff in Country 2 (τ_2)	0	+	+	0	-	-	0	-	-	-
Price Elasticity of Demand (σ)	-	-	- -	+	+	++	+	+	++	++
Route Specific										
Market Size in Country 1 (L_1)	-	-	- -	+	+	++	+	+	++	++
Market Size in Country 2 (L_2)	0	-	-	0	+	+	0	+	+	+
Airport Productivity in Country 1 (ξ_1)	-	-	- -	+	+	++	+	+	++	++
Airport Productivity in Country 2 (ξ_1)	-	-	- -	+	+	++	+	+	++	++
Fixed Costs of Exporting to Country 1 (F_1)	+	+	++	-	-	- -	-	-	- -	- -
Fixed Costs of Exporting to Country 2 (F_2)	0	+	+	0	-	-	0	-	-	-
Fixed Entry Costs into Air Cargo Shipping (F^a)	0	+	+	0	-	-	0	-	-	-

Columns (1) and (2) correspond to $\tilde{\delta}_{\underline{\varphi}_1,x}$ and $-\frac{\delta_{\mathrm{N}^c,x}}{(\kappa+1)\mathrm{N}^c-1}$ derived in equation (3.29). Columns (3) and (4) are derived as implied by $\delta_{EM_1,\underline{\varphi}_1}\left(\frac{\mathrm{d}\underline{\varphi}_1}{\mathrm{d}x}\frac{x}{\underline{\varphi}_1}\right)$ in equation (3.30). Columns (6) and (7) correspond to $\tilde{\delta}_{\mathrm{IM}_1,x}-(\kappa+1-\sigma)\,\tilde{\delta}_{\underline{\varphi}_1,x}$ and $\left[\frac{\kappa}{\mathrm{N}^c(\kappa+1)-1}\right]\delta_{\mathrm{N}^c,x}$ derived in equation (3.31). The net effect on a country's volume of exports corresponds to equation (3.31).

Table 3.3: Countries in Sample.

Countries Included in the Sample.		
Australia	Finland	Netherlands
Austria	Greece	New Zealand
Belgium	Hong Kong	Norway
Bulgaria	Hungary	Poland
Canada	Japan	Singapore
China	Republic of South Korea	Slovakia
Czech Republic	Latvia	Slovenia
Denmark	Macao	Spain
Estonia	Malaysia	Sweden
Federal Republic Of Germany	Malta And Gozo	Switzerland
		United Kingdom

Sample: 1990 − 2009. Source: US-Import of Merchandize, BTS- T-100 Database, ATRS Dataset and World Bank WDI.

Table 3.4: Summary Statistics.

Variables	Mean	Stdev.	Min.	Max.	Percentile	
					P50	P75
Endogenous Variables						
Air Cargo Shipping per kilogram (ln)	0.992	1.128	-9.868	9.873	1.064	1.526
Competition in Air Cargo						
Number of Cargo Carriers	20.620	13.237	1.000	83.000	20.000	31.000
Herfindahl Index	3,469	2,496	811	10000	2,691	4,586
Herfindahl Index (ln)	-1.296	0.686	-2.512	0.000	-1.313	-0.780
Country Specific						
Foreign Airport Cargo Handling Cost (ln)	3.861	1.520	0.870	7.794	3.701	5.328
Product Specific						
Product price at factory gate (ln)	3.252	2.621	-10.473	15.948	2.841	4.591
Ocean Cargo Shipping per kilogram (ln)	-0.984	1.120	-16.319	9.319	-0.995	-0.400
Interactions						
Number of Cargo Carriers (ln) × Foreign Airport Cargo Handling Costs (ln)	10.482	5.662	0.000	21.761	9.174	15.250

Sample: 1990 − 2009. Statistics obtained using 696, 981 observations corresponding to exports of 18, 756 products from 31 countries to the US market.

Table 3.5: Air Shipping Prices and Competition

Dependant Variable: Air Cargo Shipping per kilogram $\ln f_{\varphi j}$	Number of Cargo Carriers (1)	(2)	(3)	Herfindahl (4)	Inter. (5)
Foreign Airport Cargo Handling Cost (ln)	.249	.244	.247	.257	.183
	(.008)***	(.008)***	(.008)***	(.008)***	(.009)***
Competition in Air Cargo	-.111	-.107	-.107	.117	-.319
	(.005)***	(.005)***	(.005)***	(.006)***	(.010)***
Per Unit Price at Factory Gate (ln)		.053	.042	.042	.042
		(.002)***	(.002)***	(.002)***	(.002)***
Shipping Price of Ocean Mode (ln)			.067	.067	.067
			(.002)***	(.002)***	(.002)***
Competition in Air Cargo × Airpot Handling Costs (ln)					.058
					(.002)***
Obs.	696981	696981	696981	696981	696981
R^2 overall	.037	.037	.059	.059	.06
Product Fixed Effects	Yes	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes

Sample: 1990−2009. In columns 1−3 competition in Air Cargo is measured by the number of cargo carriers in a cargo route. In column 4 competition in air cargo is measured by the logarithm of the Herfindahl Index of a cargo route. In Column 5, I interact the logarithm of the number of cargo carries with the logarithm of a foreign's airport cargo handling cost. In all specifications I include product, country and year fixed effects. Robust Standard Errors reported in parenthesis. ***, ** and * are significant at 1%, 5% and 10% respectively.

Table 3.6: Air Shipping Prices by Cargo Load

Panel A: Number of Cargo Carriers per Route.

Dependant Variable:	Cargo by weight bin									
Air Cargo Shipping per kilogram ln $f_{\varphi j}$	1	2	3	4	5	6	7	8	9	10
Foreign Airport Cargo Handling Cost (ln)	.265	.267	.259	.285	.271	.310	.278	.258	.238	.235
	(.031)***	(.026)***	(.025)***	(.024)***	(.023)***	(.022)***	(.022)***	(.020)***	(.019)***	(.017)***
Competition in Air Cargo	-.125	-.110	-.096	-.105	-.074	-.101	-.087	-.067	-.030	-.074
	(.020)***	(.017)***	(.016)***	(.016)***	(.015)***	(.015)***	(.014)***	(.013)***	(.013)**	(.010)***
Per Unit Price at Factory Gate (ln)	.018	.024	.031	.030	.032	.027	.035	.032	.039	.023
	(.004)***	(.004)***	(.004)***	(.004)***	(.004)***	(.004)***	(.004)***	(.005)***	(.005)***	(.006)***
Shipping Price of Ocean Mode (ln)	.024	.042	.044	.053	.053	.069	.072	.072	.069	.087
	(.005)***	(.004)***	(.005)***	(.005)***	(.005)***	(.006)***	(.006)***	(.006)***	(.007)***	(.007)***
Obs.	70229	69528	69670	69626	69599	69754	69716	69670	69722	69467
R^2 overall	.059	.063	.059	.062	.062	.072	.075	.091	.122	.182

Panel B: Herfindahl Index per Cargo Route.

Dependant Variable:	Cargo by weight bin									
Air Cargo Shipping per kilogram ln $f_{\varphi j}$	1	2	3	4	5	6	7	8	9	10
Foreign Airport Cargo Handling Cost (ln)	.284	.291	.261	.281	.294	.324	.272	.249	.236	.220
	(.032)***	(.026)***	(.025)***	(.025)***	(.023)***	(.023)***	(.022)***	(.021)***	(.020)***	(.018)***
Competition in Air Cargo	.145	.138	.095	.096	.102	.116	.075	.051	.027	.050
	(.022)***	(.018)***	(.017)***	(.017)***	(.017)***	(.016)***	(.015)***	(.014)***	(.014)*	(.012)***
Per Unit Price at Factory Gate (ln)	.018	.024	.031	.030	.031	.027	.035	.032	.039	.023
	(.004)***	(.004)***	(.004)***	(.004)***	(.004)***	(.004)***	(.004)***	(.005)***	(.005)***	(.006)***
Shipping Price of Ocean Mode (ln)	.025	.042	.044	.053	.053	.069	.072	.073	.069	.087
	(.005)***	(.004)***	(.005)***	(.005)***	(.005)***	(.006)***	(.006)***	(.006)***	(.007)***	(.007)***
Obs.	70229	69528	69670	69626	69599	69754	69716	69670	69722	69467
R^2 overall	.06	.064	.06	.062	.063	.072	.075	.091	.122	.182
Product Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Sample: 1990 – 2009. Weight bins are constructed sorting the cargo load in a cargo route by a shipment total weight content. Then I classify shipments in 10 equally sized bins. Panel A provides the results obtained when I measured competition in a cargo route with the count of carriers. Panel B reports the results obtained when competition is measured with a Herfindahl Index. Robust Standard Errors reported in parenthesis. ***, ** and * are significant at 1%, 5% and 10% respectively.

Appendix

Appendix A

From equation 3.7a I take the partial respect to f_1 obtaining:

$$\frac{\partial W_1}{\partial f_1} = -\sigma \frac{\nu W_1}{w + \nu f_1} + \frac{W_1}{\int_{\underline{\varphi}_1}^{\infty} \varphi^{\sigma-1} \mathrm{d}G(\varphi)} \times \frac{\partial \int_{\underline{\varphi}_1}^{\infty} \varphi^{\sigma-1} \mathrm{d}G(\varphi)}{\partial f_1} \tag{3.34}$$

Multiplying by $\frac{f_1}{W_1}$ I obtain that the price elasticity of cargo can be decomposed in an intensive and extensive margin as follows:

$$\xi_{f_1} = \underbrace{-\sigma \frac{\nu f_1}{w + \nu f_1}}_{\text{intensive margin}} + \underbrace{\frac{f_1}{\int_{\underline{\varphi}_1}^{\infty} \varphi^{\sigma-1} \mathrm{d}G(\varphi)} \times \frac{\partial \int_{\underline{\varphi}_1}^{\infty} \varphi^{\sigma-1} \mathrm{d}G(\varphi)}{\partial f_1}}_{\text{extensive margin}} \tag{3.35}$$

$$\xi_{f_1} = \underbrace{-\sigma \frac{\nu f_1}{w + \nu f_1}}_{\text{intensive margin}} - \underbrace{\frac{f_1}{\int_{\underline{\varphi}_1}^{\infty} \varphi^{\sigma-1} \mathrm{d}G(\varphi)} \times \underline{\varphi}_1^{\sigma-1} g(\underline{\varphi}_1) \frac{\partial \underline{\varphi}_1}{\partial f_1}}_{\text{extensive margin}} \tag{3.36}$$

$$\xi_{f_1} = \underbrace{-\sigma \frac{\nu f_1}{w + \nu f_1}}_{\text{intensive margin}} - \underbrace{\frac{\underline{\varphi}_1^{\sigma}}{\int_{\underline{\varphi}_1}^{\infty} \varphi^{\sigma-1} \mathrm{d}G(\varphi)} \times g(\underline{\varphi}_1) \frac{\partial \underline{\varphi}_1 f_1}{\partial f_1 \underline{\varphi}_1}}_{\text{extensive margin}} \tag{3.37}$$

From equation 3.6b I obtain:

$$\frac{\partial \underline{\varphi}_1}{\partial f_1}\frac{f_1}{\underline{\varphi}_1} = \frac{\nu f_1}{w+\nu f_1} \tag{3.38}$$

Substituting 3.38 in 3.37 I obtain:

$$\xi_{f_1} = \underbrace{-\sigma\frac{\nu f_1}{w+\nu f_1}}_{\text{intensive margin}} - \underbrace{\frac{\underline{\varphi}_1{}^{\sigma}}{\int_{\underline{\varphi}_1}^{\infty}\varphi^{\sigma-1}\mathrm{d}G(\varphi)} \times g(\underline{\varphi}_1)\frac{\nu f_1}{w+\nu f_1}}_{\text{extensive margin}} \tag{3.39}$$

$$\xi_{f_1} = -\left[\frac{\nu f_1}{w+\nu f_1}\right]\left[\sigma + \frac{\underline{\varphi}_1{}^{\sigma}}{\int_{\underline{\varphi}_1}^{\infty}\varphi^{\sigma-1}\mathrm{d}G(\varphi)} \times g(\underline{\varphi}_1)\right] \tag{3.40}$$

Under the assumption that φ is Pareto with $G(\varphi) = 1 - \frac{1}{\kappa}\varphi^{-\kappa}$: $\varphi \in [\underline{b}, \infty)$ and shape parameter $\kappa > 2$. Implying that the pdf is $g(\varphi) = \varphi^{-\kappa-1}$. Therefore:

$$g\left(\underline{\varphi}_1\right) = \underline{\varphi}_1{}^{-\kappa-1} \tag{3.41a}$$

$$\int_{\underline{\varphi}_1}^{\infty}\varphi^{\sigma-1}\mathrm{d}G(\varphi) = \left[\frac{1}{\sigma-\kappa-1}\right]\left[\left(\frac{1}{\infty}\right)^{\kappa+1-\sigma} - \left(\frac{1}{\underline{\varphi}_1}\right)^{\kappa+1-\sigma}\right] \tag{3.41b}$$

$$\int_{\underline{\varphi}_1}^{\infty}\varphi^{\sigma-1}\mathrm{d}G(\varphi) = \left[\frac{1}{\kappa+1-\sigma}\right]\left[-\underbrace{\left(\frac{1}{\infty}\right)^{\kappa+1-\sigma}}_{0} + \left(\frac{1}{\underline{\varphi}_1}\right)^{\kappa+1-\sigma}\right] \tag{3.41c}$$

$$\int_{\underline{\varphi}_1}^{\infty}\varphi^{\sigma-1}\mathrm{d}G(\varphi) = \left[\frac{1}{\kappa+1-\sigma}\right]\underline{\varphi}_1{}^{\sigma-\kappa-1} \tag{3.41d}$$

Substituting equations 3.41a and 3.41d in 3.40 I obtain:

$$\xi_{f_1} = -\left(\kappa+1\right)\frac{\nu f_1}{w+\nu f_1} \tag{3.42}$$

Appendix B

Setting the optimal profit function of a representative air carrier to zero I obtain:

$$w^{\frac{\kappa+1-\sigma}{\sigma-1}} F^a = \frac{\left[\text{N}^c\left(\kappa+1\right)-1\right]^{\kappa}}{\left[\text{N}^c\right]^{\kappa+2}} \underbrace{\left[\frac{\left(\sigma-1\right)^{\kappa+1}}{\left(\kappa+1-\sigma\right)\left(1+\kappa\right)^{\kappa+1}\sigma^{\frac{\sigma\kappa}{\sigma-1}}}\right]}_{\text{H}_{\sigma\kappa}} \times \tag{3.43a}$$

$$\left[\underbrace{\left[\frac{\text{L}_1^{\kappa} p_o^{\kappa\sigma}}{\tau_1^{\sigma\kappa} F_1^{\kappa+1-\sigma}}\right]^{\frac{1}{\sigma-1}}\left[\frac{1+\nu\text{B}_1}{\left(w+\nu\text{B}_1\right)^{\kappa+1}}\right]}_{\text{H}_1} + \underbrace{\left[\frac{\text{L}_2^{\kappa} p_o^{\kappa\sigma}}{\tau_2^{\sigma\kappa} F_2^{\kappa+1-\sigma}}\right]^{\frac{1}{\sigma-1}}\left[\frac{1+\nu\text{B}_2}{\left(w+\nu\text{B}_2\right)^{\kappa+1}}\right]}_{\text{H}_2}\right]$$

$$\text{NC} = \text{N}^{c\,\frac{\kappa+2}{\kappa}} \underbrace{\left[\frac{w^{\frac{\kappa+1-\sigma}{\kappa(\sigma-1)}}}{\kappa+1}\right]\left[\frac{F^a}{\left(\text{H}_1+\text{H}_2\right)\text{H}_{\sigma\kappa}}\right]^{\frac{1}{\kappa}}}_{\text{H}_3} - \text{N}^c + \frac{1}{\kappa+1} \tag{3.43b}$$

As implied by equations 3.44a and 3.44b, NC is a continuous convex differentiable function on N^c.

$$\text{NC}' = \left[\frac{\kappa+2}{\kappa}\right]\text{H}_3 \text{N}^{c\,\frac{2}{\kappa}} - 1 \tag{3.44a}$$

$$\text{NC}'' = \left[\frac{2\left(\kappa+2\right)}{\kappa^2}\right]\text{H}_3 \text{N}^{c\,-\frac{\kappa-2}{\kappa}} > 0 \tag{3.44b}$$

Conditional of the value of H_3, NC will achieves a minimum in $\underline{\text{N}}^c = \left[\frac{\kappa}{\text{H}_3(\kappa+2)}\right]^{\frac{\kappa}{2}}$. It will exhibit a decreasing pattern $\forall \quad \text{N}^c \in (0, \underline{\text{N}}^c]$, and exhibit an increasing pattern $\forall \quad \text{N}^c \in (\underline{\text{N}}^c, \infty)$.

Appendix C

From equation (3.20) I obtain:

$$\frac{\mathrm{d}f_j}{\mathrm{d}x} = \frac{\partial f_j}{\partial x} + \frac{\partial f_j}{\partial \mathrm{N}^c}\frac{\partial \mathrm{N}^c}{\partial x} \tag{3.45a}$$

Factorizing by $\frac{f_j}{x}$ and multiplying and dividing the second term in equation (3.45a) by N^c I get:

$$\frac{\mathrm{d}f_j}{\mathrm{d}x} = \left[\frac{f_j}{x}\right]\left[\frac{\partial f_j}{\partial x}\frac{x}{f_j} + \left(\frac{\partial f_j}{\partial \mathrm{N}^c}\frac{\mathrm{N}^c}{f_j}\right)\left(\frac{\partial \mathrm{N}^c}{\partial x}\frac{x}{\mathrm{N}^c}\right)\right] \tag{3.45b}$$

$$\frac{\mathrm{d}f_j}{\mathrm{d}x} = \left[\frac{f_j}{x}\right]\left[\tilde{\delta}_{f_j,x} + \delta_{\mathrm{N}^c f_j}\delta_{\mathrm{N}^c,x}\right] \tag{3.45c}$$

$$\frac{\mathrm{d}f_j}{\mathrm{d}x}\frac{x}{f_j} = \tilde{\delta}_{f_j,x} + \delta_{f_j,\mathrm{N}^c}\delta_{\mathrm{N}^c,x} \tag{3.45d}$$

$$\delta_{f_j,x} = \tilde{\delta}_{f_j,x} + \delta_{f_j,\mathrm{N}^c}\delta_{\mathrm{N}^c,x} \tag{3.45e}$$

From equation (3.20) I obtain:

$$\frac{\mathrm{d}p_{\varphi j}}{\mathrm{d}x} = \frac{\partial p_{\varphi j}}{\partial x} + \frac{\partial p_{\varphi j}}{\partial f_j}\frac{\mathrm{d}f_j}{\mathrm{d}x} \tag{3.46a}$$

Factorizing by $\frac{p_{\varphi j}}{x}$ and multiplying and dividing by f_j in the second term of equation (3.46a) I obtain:

$$\frac{\mathrm{d}p_{\varphi j}}{\mathrm{d}x} = \left[\frac{p_{\varphi j}}{x}\right]\left[\frac{\partial p_{\varphi j}}{\partial x}\frac{x}{p_{\varphi j}} + \left(\frac{\partial p_{\varphi j}}{\partial f_j}\frac{f_j}{p_{\varphi j}}\right)\left(\frac{\mathrm{d}f_j}{\mathrm{d}x}\frac{x}{f_j}\right)\right] \tag{3.46b}$$

From equation (3.4b) I get that $\frac{\partial p_{\varphi j}}{\partial x}\frac{x}{p_{\varphi j}} = \frac{\frac{\nu}{\varphi}f_j}{p_{\varphi j}} = \frac{\nu f_j}{w+\nu f_j} = \mathrm{S}_{f_j}$.

$$\frac{\mathrm{d}p_{\varphi j}}{\mathrm{d}x} = \left[\frac{p_{\varphi j}}{x}\right]\left[\frac{\partial p_{\varphi j}}{\partial x}\frac{x}{p_{\varphi j}} + \mathrm{S}_{f_j}\left(\frac{\mathrm{d}f_j}{\mathrm{d}x}\frac{x}{f_j}\right)\right] \tag{3.46c}$$

Substituting equation (3.45d) I get:

$$\frac{\mathrm{d}p_{\varphi j}}{\mathrm{d}x} = \left[\frac{p_{\varphi j}}{x}\right]\left[\tilde{\delta}_{p_{\varphi j},x} + \mathrm{S}_{f_j}\left(\tilde{\delta}_{f_j,x} + \delta_{f_j,\mathrm{N}^c}\delta_{\mathrm{N}^c,x}\right)\right] \tag{3.46d}$$

$$\frac{\mathrm{d}p_{\varphi j}}{\mathrm{d}x}\frac{x}{p_{\varphi j}} = \tilde{\delta}_{p_{\varphi j},x} + \mathrm{S}_{f_j}\left[\tilde{\delta}_{f_j,x} + \delta_{f_j,\mathrm{N}^c}\delta_{\mathrm{N}^c,x}\right] \tag{3.46e}$$

$$\delta_{p_{\varphi j},x} = \tilde{\delta}_{p_{\varphi j},x} + \mathrm{S}_{f_j}\tilde{\delta}_{f_j,x} + \mathrm{S}_{f_j}\delta_{f_j,\mathrm{N}^c}\delta_{\mathrm{N}^c,x} \tag{3.46f}$$

From equation 3.2a I obtain:

$$\frac{\mathrm{d}q_{\varphi j}}{\mathrm{d}x} = \frac{\partial q_{\varphi j}}{\partial x} + \frac{\partial q_{\varphi j}}{\partial p_{\varphi j}}\frac{\mathrm{d}p_{\varphi j}}{\mathrm{d}x} \tag{3.47a}$$

Factorizing by $\frac{q_{\varphi j}}{x}$ and multiplying and dividing the second term in equation (3.47a) I get:

$$\frac{\mathrm{d}q_{\varphi j}}{\mathrm{d}x} = \left[\frac{q_{\varphi j}}{x}\right]\left[\frac{\partial q_{\varphi j}}{\partial x}\frac{x}{q_{\varphi j}} + \left(\frac{\partial q_{\varphi j}}{\partial p_{\varphi j}}\frac{p_{\varphi j}}{q_{\varphi j}}\right)\left(\frac{\mathrm{d}p_{\varphi j}}{\mathrm{d}x}\frac{x}{p_{\varphi j}}\right)\right] \tag{3.47b}$$

By equation (3.2a) I know that $\frac{\partial q_{\varphi j}}{\partial p_{\varphi j}}\frac{p_{\varphi j}}{q_{\varphi j}} = -\sigma$.

$$\frac{\mathrm{d}q_{\varphi j}}{\mathrm{d}x} = \left[\frac{q_{\varphi j}}{x}\right]\left[\frac{\partial q_{\varphi j}}{\partial x}\frac{x}{q_{\varphi j}} - \sigma\left(\frac{\mathrm{d}p_{\varphi j}}{\mathrm{d}x}\frac{x}{p_{\varphi j}}\right)\right] \tag{3.47c}$$

$$\frac{\mathrm{d}q_{\varphi j}}{\mathrm{d}x} = \left[\frac{q_{\varphi j}}{x}\right]\left[\tilde{\delta}_{q_{\varphi j},x} - \sigma\left[\tilde{\delta}_{p_{\varphi j},x} + \mathrm{S}_{f_j}\left(\frac{\mathrm{d}f_j}{\mathrm{d}x}\frac{x}{f_j}\right)\right]\right] \tag{3.47d}$$

(3.47e)

Substituting equation (3.45d) into equation (3.47d) I obtain:

$$\frac{\mathrm{d}q_{\varphi j}}{\mathrm{d}x} = \left[\frac{q_{\varphi j}}{x}\right]\left[\tilde{\delta}_{q_{\varphi j},x} - \sigma\tilde{\delta}_{p_{\varphi j},x} - \sigma\mathrm{S}_{f_j}\tilde{\delta}_{f_j,x} - \sigma\mathrm{S}_{f_j}\delta_{f_j,\mathrm{N}^c}\delta_{\mathrm{N}^c,x}\right] \tag{3.47f}$$

$$\frac{\mathrm{d}q_{\varphi j}}{\mathrm{d}x}\frac{x}{q_{\varphi j}} = \tilde{\delta}_{q_{\varphi j},x} - \sigma\tilde{\delta}_{p_{\varphi j},x} - \sigma\mathrm{S}_{f_j}\tilde{\delta}_{f_j,x} - \sigma\mathrm{S}_{f_j}\delta_{f_j,\mathrm{N}^c}\delta_{\mathrm{N}^c,x} \tag{3.47g}$$

$$\delta_{q_{\varphi j},x} = \tilde{\delta}_{q_{\varphi j},x} - \sigma\tilde{\delta}_{p_{\varphi j},x} - \sigma\mathrm{S}_{f_j}\tilde{\delta}_{f_j,x} - \sigma\mathrm{S}_{f_j}\delta_{f_j,\mathrm{N}^c}\delta_{\mathrm{N}^c,x} \tag{3.47h}$$

$$\frac{\mathrm{d}r_{\varphi j}}{\mathrm{d}x} = \frac{\mathrm{d}p_{\varphi j}}{\mathrm{d}x}\, q_{\varphi j} + p_{\varphi j}\, \frac{\mathrm{d}q_{\varphi j}}{\mathrm{d}x} \tag{3.48a}$$

Factorizing by $\frac{p_{\varphi j} q_{\varphi j}}{x}$ I obtain:

$$\frac{\mathrm{d}r_{\varphi j}}{\mathrm{d}x} = \left[\frac{p_{\varphi j} q_{\varphi j}}{x}\right] \left[\frac{\mathrm{d}p_{\varphi j}}{\mathrm{d}x}\, \frac{x}{p_{\varphi j}} + \frac{\mathrm{d}q_{\varphi j}}{\mathrm{d}x}\, \frac{x}{q_{\varphi j}}\right] \tag{3.48b}$$

Substituting equations (3.46e) and (3.47g) in equation (3.48b) I obtain:

$$\frac{\mathrm{d}r_{\varphi j}}{\mathrm{d}x} = \left[\frac{r_{\varphi j}}{x}\right] \left[\tilde{\delta}_{q_{\varphi j},x} - (\sigma - 1)\left[\tilde{\delta}_{p_{\varphi j},x} + \mathrm{S}_{f_j}\left(\frac{\mathrm{d}f_j}{\mathrm{d}x}\, \frac{x}{f_j}\right)\right]\right] \tag{3.48c}$$

Substituting equation (3.45d) in equation (3.48c) I obtain:

$$\frac{\mathrm{d}r_{\varphi j}}{\mathrm{d}x} = \left[\frac{r_{\varphi j}}{x}\right] \left[\tilde{\delta}_{q_{\varphi j},x} - (\sigma - 1)\left(\tilde{\delta}_{p_{\varphi j},x} + \mathrm{S}_{f_j}\tilde{\delta}_{f_j,x} + \mathrm{S}_{f_j}\delta_{f_j,\mathrm{N}^c}\delta_{\mathrm{N}^c,x}\right)\right] \tag{3.48d}$$

$$\frac{\mathrm{d}r_{\varphi j}}{\mathrm{d}x}\, \frac{x}{r_{\varphi j}} = \tilde{\delta}_{q_{\varphi j},x} - (\sigma - 1)\left(\tilde{\delta}_{p_{\varphi j},x} + \mathrm{S}_{f_j}\tilde{\delta}_{f_j,x} + \mathrm{S}_{f_j}\delta_{f_j,\mathrm{N}^c}\delta_{\mathrm{N}^c,x}\right) \tag{3.48e}$$

$$\delta_{r_{\varphi j},x} = \tilde{\delta}_{q_{\varphi j},x} - (\sigma - 1)\left(\tilde{\delta}_{p_{\varphi j},x} + \mathrm{S}_{f_j}\tilde{\delta}_{f_j,x} + \mathrm{S}_{f_j}\delta_{f_j,\mathrm{N}^c}\delta_{\mathrm{N}^c,x}\right) \tag{3.48f}$$

From equation (3.19a), entry into market 1 can be generalized by $\underline{\varphi}_1(\vec{x}, \mathrm{N}^c(\vec{x}))$. A shock to x implies:

$$\frac{\mathrm{d}\underline{\varphi}_1}{\mathrm{d}x} = \frac{\partial \underline{\varphi}_1}{\partial x} + \frac{\partial \underline{\varphi}_1}{\partial \mathrm{N}^c}\, \frac{\partial \mathrm{N}^c}{\partial x} \tag{3.49a}$$

$$\frac{\mathrm{d}\underline{\varphi}_1}{\mathrm{d}x} = \left[\frac{\underline{\varphi}_1}{x}\right] \left[\frac{\partial \underline{\varphi}_1}{\partial x}\, \frac{x}{\underline{\varphi}_1} + \left(\frac{\partial \underline{\varphi}_1}{\partial \mathrm{N}^c}\, \frac{\mathrm{N}^c}{\underline{\varphi}_1}\right)\left(\frac{\partial \mathrm{N}^c}{\partial x}\, \frac{\mathrm{N}^c}{x}\right)\right] \tag{3.49b}$$

$$\frac{\mathrm{d}\underline{\varphi}_1}{\mathrm{d}x} = \frac{\underline{\varphi}_1}{x}\left[\tilde{\delta}_{\underline{\varphi}_1,x} + \delta_{\underline{\varphi}_1,\mathrm{N}^c}\delta_{\mathrm{N}^c,x}\right] \tag{3.49c}$$

$$\frac{\mathrm{d}\underline{\varphi}_1}{\mathrm{d}x}\, \frac{x}{\underline{\varphi}_1} = \tilde{\delta}_{\underline{\varphi}_1,x} + \delta_{\underline{\varphi}_1,\mathrm{N}^c}\delta_{\mathrm{N}^c,x} \tag{3.49d}$$

From equation (3.19a) I know that $\delta_{\underline{\varphi}_1,\mathrm{N}^c} = -\frac{1}{\mathrm{N}^c(\kappa+1)-1}$. Substituting $\delta_{\underline{\varphi}_1,\mathrm{N}^c}$ in equation (3.49d) I get:

$$\frac{\mathrm{d}\underline{\varphi}_1}{\mathrm{d}x}\frac{x}{\underline{\varphi}_1} = \tilde{\delta}_{\underline{\varphi}_1,x} - \frac{\delta_{\mathrm{N}^c,x}}{\mathrm{N}^c(\kappa+1)-1} \tag{3.49e}$$

As implied by equations (3.18b) and (3.18c) the total volume of exports can be re-expressed by

$$\mathrm{IMP}_1 = \mathrm{IM}_1(x, \mathrm{N}^c(x))\mathrm{EM}_1(\underline{\varphi}_1(x, \mathrm{N}^c(x))) \tag{3.50a}$$

Impliying,

$$\frac{\mathrm{dIMP}_1}{\mathrm{d}x} = \mathrm{EM}_1\left[\frac{\partial \mathrm{IM}_1}{\partial x} + \frac{\partial \mathrm{IM}_1}{\partial \mathrm{N}^c}\frac{\partial \mathrm{N}^c}{\partial x}\right] + \mathrm{IM}_1\left[\frac{\partial \mathrm{EM}_1}{\partial \underline{\varphi}_1}\frac{\mathrm{d}\underline{\varphi}_1}{\mathrm{d}x}\right] \tag{3.50b}$$

Factorizing by $\frac{\mathrm{IM}_1\mathrm{EM}_1}{x}$ and multiplying and dividing the second bracket by $\underline{\varphi}_1$ I obtain:

$$\begin{aligned}\frac{\mathrm{dIMP}_1}{\mathrm{d}x} = \frac{\mathrm{IM}_1\mathrm{EM}_1}{x}&\left[\frac{\partial \mathrm{IM}_1}{\partial x}\frac{x}{\mathrm{IM}_1} + \left(\frac{\partial \mathrm{IM}_1}{\partial \mathrm{N}^c}\frac{\mathrm{N}^c}{\mathrm{IM}_1}\right)\left(\frac{\partial \mathrm{N}^c}{\partial x}\frac{x}{\mathrm{N}^c}\right)\right] \\ &+ \frac{\mathrm{IM}_1\mathrm{EM}_1}{x}\left[\left(\frac{\partial \mathrm{EM}_1}{\partial \underline{\varphi}_1}\frac{\underline{\varphi}_1}{\mathrm{EM}_1}\right)\left(\frac{\mathrm{d}\underline{\varphi}_1}{\mathrm{d}x}\frac{x}{\underline{\varphi}_1}\right)\right]\end{aligned} \tag{3.50c}$$

Substituting equation (3.49d) into equation (3.50c) I obtain:

$$\frac{\mathrm{dIMP}_1}{\mathrm{d}x} = \frac{\mathrm{IM}_1\mathrm{EM}_1}{x}\left[\tilde{\delta}_{\mathrm{IM}_1,x} + \delta_{\mathrm{IM}_1,\mathrm{N}^c}\delta_{\mathrm{N}^c,x} + \delta_{\mathrm{EM}_1,\underline{\varphi}_1}\left(\tilde{\delta}_{\underline{\varphi}_1,x} + \delta_{\underline{\varphi}_1,\mathrm{N}^c}\delta_{\mathrm{N}^c,x}\right)\right] \tag{3.50d}$$

From equation (3.18b) I know that $\delta_{\mathrm{IM}_1,\mathrm{N}^c} = \frac{\sigma-1}{\mathrm{N}^c(\kappa+1)-1}$ and $\delta_{\mathrm{EM}_1,\underline{\varphi}_1} = -(\kappa+1-\sigma)$. Since $\delta_{\underline{\varphi}_1,\mathrm{N}^c} = -\frac{1}{\mathrm{N}^c(\kappa+1)-1}$, I substitute these three expressions into equation (3.50d) and I obtain:

$$\frac{\mathrm{dIMP}_1}{\mathrm{d}x} = \frac{\mathrm{IM}_1\mathrm{EM}_1}{x}\left[\tilde{\delta}_{\mathrm{IM}_1,x} - (\kappa+1-\sigma)\,\tilde{\delta}_{\underline{\varphi}_1,x} + \left[\frac{\kappa}{\mathrm{N}^c(\kappa+1)-1}\right]\delta_{\mathrm{N}^c,x}\right] \tag{3.50e}$$