Statement of Research Plan

The role of Migration and Innovation in International Trade and Economic Development

by Carolina Inés Pan

Abstract

I propose using historical patenting data for a series of papers that will examine the relationship between migration patterns and invention in the US. In particular, how the country of origin of inventors determines the innovation field/sector of a specific US county, whether migration (through innovation) has shaped the comparative advantage of a region, and how do migration flows in the 19th and early 20th century predict both trade in goods and FDI flows today. The ultimate goal is to study the relationship between migration patterns and long-run development at the county or state level.

Purpose

Technological innovation makes a key contribution to economic welfare both in the country where it originated and in the rest of the world through spillover effects. This phenomenon has been widely analyzed and empirically tested by economists from different fields. Scholars in Economic Growth agree that more innovation is desirable as it leads to faster growth rates in income per capita. International Trade theorists have also identified technological innovation as a central player, fostering world trade by means of enhanced productivity. However, despite comprehensive models that describe the trade-innovation relationship, to date little work has shown empirical evidence that supports these theories. As a result, economists are certain that technology matters for trade (and development) but uncertain about how much. Without an adequate measurement of the impact of innovation on bilateral trade and the channels through which it operates, we miss the opportunity to create and implement policies that will facilitate trade and stimulate economic growth.

My main Ph.D. dissertation paper tries to fill this gap by developing a Ricardian model of innovation and trade and testing it with novel measures of technology constructed from a unique dataset of historical patenting records for all countries. I wish to extend my research on technological innovation by studying the relationship between migration patterns and invention in the US. I am currently collaborating in a major project of building a dataset that contains the country of origin of each inventor listed in every US patent since 1836. I propose using this data for a series of papers that will examine: how the country of origin of inventors determines the innovation field/sector of a specific US county, whether migration (through innovation) has shaped the comparative advantage of a region, and how do migration flows in the 19th and early 20th century predict both trade in goods and FDI flows today. The ultimate goal is to study the relationship between migration patterns and long-run development at the county or state level. Adequate policy-making requires a good understanding of the channels through which innovation impacts trade and income. This research will serve

to understand the current trade and development outcomes from a historical perspective but will also shed light on the current and very and controversial debate about the effects of immigrants in the labor market and overall welfare.

Subject and strategy

Since innovation spillovers are neither immediate nor complete, countries differ in their technological frontier: those that are able to innovate more will exploit the benefits of better technologies. Distinct innovative capabilities are a major determinant of differences across countries, and are reflected in exports. Traditional trade theory predicts that countries' trade patterns are determined by comparative advantage[1], which according to the Ricardian model of trade results from technological differences. Empirical examinations of how technological advance affects exports, however, are limited in number and scope. The main difficulty in measuring the effect is the reverse causality bias: the incidence of innovation on trade cannot be easily separated from the (simultaneous) incidence of trade on innovation. Technology affects trade through productivity as countries that innovate more in a certain good are likely to be more productive in the manufacturing and will export more. But trade also affects innovation as it serves as a technology transfer. Exports of capital goods help the importers develop new industrial capacities or upgrade existing ones[2].

My strategy to identify the true impact of innovation on bilateral exports, avoiding the reverse causality problem, lies in using variation in migration waves to the US as an innovation shock. In particular, the county and time variation in migration will allow for the inclusion of fixed effects to account for static differences in both bilateral pair and importer/exporter characteristics. In addition, the shock can also help identify the impact of technology on growth.

[1] A country has a comparative advantage in the production of a good if it enjoys a lower opportunity cost than another country.
[2] See, for example, Grossman and Helpman (1991).

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Education

expected May 2017 — Ph.D. in Economics
Brandeis University, International Business School

2012 — Master of Science in International Economics and Finance
Brandeis University, International Business School

2009 — Master of Arts in Economics
Universidad de San Andres, Argentina

2007 — Bachelor of Arts in Economics
Universidad de San Andres, Argentina

Teaching and Research Fields

Primary fields: International Trade, International Macroeconomics, Economic Development
Specializations: Economic Growth and Innovation

Research and Work Experience

Sept 2014-Dec 2015 | State Street Associates
Quantextual Research Fellow
Investor Behavior Research Team

Jan-Apr 2014 | United Nations Economic Commission for Latin America and the Caribbean (ECLAC)
Consultant
Natural Resources and Infrastructure Division

2009-2015 | Universidad de San Andres and Brandeis University
Research Assistant
R.A. for Judith Dean and R.A. for Ricardo Lopez - Brandeis University
R.A. for Sebastian Galiani and R.A for Irene Brambilla - U. de San Andres

Oct-Dec 2008 | The Inter-American Development Bank
External Consultant
Social Protection and Health Unit

Teaching Experience

Instructor	Brandeis University
Fall 2016	Empirical Trade Policy and Analysis (MA, PhD)
Summer 2013	Macroeconomic Theory (undergraduate)
Teaching Assistant	Brandeis University
2014-2016	Senior Honors Thesis
2011-2015	Macroeconomic Theory, Econometrics, International Trade Policy and Institutions, Empirical Trade Policy and Analysis, Economic Development Strategies
	Universidad de San Andres
2009-2010	Intermediate Macroeconomics, International Trade and Globalization, Economic Growth and Development, International Trade Theory

Research Papers

JOB MARKET PAPER

From Ideas to Trade (with Fernando Yu)

This paper studies how cross-country differences in the allocation of technology affect bilateral trade. Do both the stock and dispersion of technology matter for exports? We build on Eaton and Kortum (2002) and develop a Ricardian model where the process of innovation determines both the stock and dispersion of technology in each country. Like in the EK model, a higher stock of technology and lower relative input costs foster exports. Unlike in the EK model, a country's overall comparative advantage depends on the country-specific dispersion of technology which governs the advantage of having lower input costs. In particular, a smaller technological dispersion benefits countries with lower input costs since trade is determined by these and not technological differences. The opposite is true for a high dispersion. To test our model we create a novel dataset of historical patents and use these to construct our technology variables. Our results confirm our model's predictions and indicate that technological innovation matters for trade through both the stock of patents and their dispersion across the economy.

WORKING PAPERS

Distance and Trade: A Natural Experiment in South America

One of the major puzzles in the literature of empirical international trade is that the negative effect of geographic distance on bilateral trade is highly persistent in time. In this paper I exploit a natural experiment, the Pulp Mill Conflict, that took place in South America to obtain accurate estimates of the elasticity of transport costs with respect to bilateral trade. The conflict introduces a time component to the geographic distance between country pairs, which allows for the inclusion of bilateral pair fixed effects to control for all characteristics other than the time-varying distances. Results suggest that traditional gravity estimates suffer form (upward) omitted variable bias. Nevertheless, transportation costs are still very important for explaining bilateral trade.

Unveiling the pattern of technological diversification

This paper studies the evolution of the patterns of diversification in technological capabilities along the level of per capita income. Using data on historical international patents in the USPTO for 84 developed and developing countries I illustrate a U-shaped relationship between income and sectoral concentration that is consistent with the findings of Imbs and Wacziarg (2003) for production and Cadot et. al. (2011) for exports. As GDP per capita rises economies become more (technologically) diversified, until they reach a turning point where they start

specializing again. I relate this finding to various theories of innovation but offer an alternative explanation based on a Ricardian-HO hybrid model that is more consistent with the empirical regularities found in the data.

Invited Presentations

2016	Harvard Kennedy School CID Growth Lab seminar, Eurkind GCW 2016 Conference, Warsaw International Economic Meeting, 3rd Geography of Innovation Conference, 5th IISES Economics and Finance Conference, 26th International Trade and Finance Association Conference
2012-2016	Seminar Series, Brandeis University
2014	12th GLOBELICS International Conference

Honors, Scholarships and Fellowships

2016	AAUW International Fellowship
2015-2016	Latin America Initiative Grant
2014-2016	Rosenberg Summer Research Grant
2014-2016	Provost's Dissertation Award, Brandeis University
2012- 2014	Doctoral Fellowship, Brandeis University
2010-Present	IBS Scholarship, Brandeis University
2008-2009	Academic Merit Scholarship for graduate studies, Universidad de San Andres
2004-2007	Academic Merit Scholarship for undergraduate studies, Universidad de San Andres

Additional Information

Computer skills	Stata, Matlab, LaTeX
Languages	Spanish(native), English (fluent), French (intermediate), Italian (basic)
Other Activities	Volunteer for "Un techo para mi pais" (homes for the homeless in Argentina) President of the Latin Club at Brandeis IBS (2016-2017)

References

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REFERENCE FOR CAROLINA PAN

I enthusiastically recommend Carolina Pan to you for your position. I chair Carolina's dissertation committee. We first met when she took my second year MA research seminar in empirical trade policy. I quickly hired her as my TA for the class for two years. This semester, while I'm on sabbatical, she is teaching the course. Carolina has also been my research assistant for two years. Simply put, Carolina is outstanding. As a researcher, she is self-motivated, creative, insightful and thorough. Her research program for her dissertation is highly creative, and showcases her unusual talent for both theoretical and empirical economic research. She is also a terrific teacher, and has been selected multiple times to be the teaching assistant for undergraduate student honors theses in the economics department.
This year she won a prestigious American Association of University Women International Fellowship Award to complete her dissertation work.

Carolina's job market paper and a second paper focus on innovation as a facilitator of international trade. The third paper in her dissertation explores distance as an impediment to trade. The job market paper and third paper are completed, and the second is well under way. She has an additional paper beyond the dissertation already begun. Carolina's work is sole-authored, with the exception of her job market paper. However, this work is really all her own, as her coauthor's role was confined to one small contribution.[1] In what follows I will first discuss her two papers on innovation, then turn to the paper on distance and her new research, and her teaching.

Carolina's motivation for studying the impact of innovation on international trade resulted from two unusual empirical relationships discovered by Imbs and Wacziarg (2003) and Cadot, et al. (2011). These two studies established a U-shaped relationship between GDP and diversification in production, and GDP and diversification in exports, respectively. As countries grow, their production and exports are initially highly specialized, become more diversified and then eventually become more specialized again. Carolina suspected that the diversification of technological innovation across industries might explain these phenomena. She traveled to the Netherlands to obtain a unique dataset on patents for 100 countries, spanning about 100 years. The unusual patterns she found in these data are at the root of both papers.

In her job market paper, "From Ideas to Trade," Carolina argues that the distribution of innovation across industries should affect comparative advantage, and thereby, the likelihood of being a major exporter of a product. This is a fundamental tenet of the original Ricardian model. Examining the patent data, Carolina finds that innovation varies widely across industries and countries. Her first contribution is, therefore, to extend the seminal paper by Eaton and Kortum (2002) (EK) to incorporate this. EK use a Ricardian model with a continuum of goods to explain how the stock of knowledge affects trade. EK argue that a larger technology stock increases a country's absolute advantage in production. For any given set of relative input costs, an increase in one country's technology stock should increase that country's cost advantage across all products relative to its

[1] Mr. Yu helped develop a closed form solution for an integral expression, which facilitated the interpretation and estimation of the model.

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trade partners. The distribution of technology across industries is assumed to be identical for all countries, so only the level of technology and relative inputs costs affect the likelihood of being a major exporter of any good.

Carolina introduces country-specific technology dispersion into the EK model, and shows that this variation affects the likelihood that a country will be the lowest cost producer of any product. If every country has the same technological dispersion across industries, her model reduces to EK, and the probability of exporting depends upon the stock of knowledge and relative input costs compared to trading partners. In Carolina's extended model a third term appears, that, in effect, interacts relative input costs with industrial technology concentration. For a given country and relative inputs costs, a higher concentration of technology in some industries will increase the probability that this country will be the most efficient producer, and therefore a larger exporter of these goods. Thus, uneven technological innovation enhances comparative advantage.

To take her theory to the data, Carolina needs a measure of technology dispersion. Her second contribution is her novel approach to measuring this dispersion. She uses an idea-generating model developed by Kortum (1997) that relates the arrival of new ideas to the stock, quality and dispersion of existing ideas. She follows the literature in using patent counts to proxy the stock of technology, and citation counts to proxy quality. This allows her to directly estimate her technology dispersion variable. With this in hand, she is able to show evidence of variation in the stock and dispersion of technology across countries, and the evolution of these over time. She is also able to demonstrate that, in the context of her theory, this technology dispersion affects a country's productivity distribution across industries.

Her third contribution is her empirical test. As with EK, Carolina's model can be estimated with a gravity equation. Using an uneven panel of data on 84 countries from 1980-2000, she first shows evidence that corroborates EK's results. An increase in a country's stock of knowledge, or a reduction in its input costs, relative to its trading partners, both increase that country's bilateral exports. She then shows robust evidence that increased technology dispersion (more uneven distribution of technology) across industries also increases bilateral exports. In particular, as the model predicts, increased technology dispersion reduces the importance of relative input costs as a determinant of bilateral exports.

Her second paper on innovation and trade, "Unveiling the Pattern of Technological Diversification," returns to the patent data. Here she first shows that there is a distinct U-shaped pattern between GDP and innovation diversification across industries. At low income levels countries seem to innovate in only a few industries. At higher income levels, innovation is much more widespread across industries. As income grows even more, innovation again becomes concentrated in fewer industries. She then argues that this finding is consistent with the two U-shaped patterns between GDP and production diversification, and GDP and export diversification. She is currently developing a theoretical model, based on a hybrid of the Ricardian and Heckscher-Ohlin models that will demonstrate how innovation might be able to explain these other two patterns.

In her third paper, "Distance and Trade: a Natural Experiment in South America," Carolina studies the long-term puzzle that distance is a large impediment to trade. This much-debated result suggests that transport costs have surprising large negative effects on trade that are persistent through time despite radical cost-savings in the last half century. Many studies have argued that the distance variable is a proxy for other omitted variables. But the typical fixed effects solution is not feasible since distance does not vary over time. Carolina designs a new way to test the role of distance in a gravity model, making use of the 3-year closing of a bridge between Uruguay and Argentina. The bridge is the most direct route for goods to travel between Mercosur members (including associate members). The blockade diverted shipping to alternative bridges, raising transport costs. Thus, distance did vary over time.

Carolina measures the shortest available transport route for each bilateral pair before, after and during the blockade. This allows her to estimate a theory-based gravity model that includes country-time effects to proxy multilateral resistance terms and bilateral pair fixed effects. She traveled to ECLAC to collect and analyze their Latin American disaggregated trade data, which includes modes of transport. This allowed her to refine her gravity estimates to correct for the share of products carried by road, to verify the typical routes that these shipments traveled, and to accurately track the diversion of shipments to other bridges. She provides robust evidence that the actual impact of a change in distance on trade is about 40% lower than the average estimates in the literature.

Beyond the dissertation, Carolina is continuing to work on innovation and trade. She has already collected extensive, firm-level data on Brazil. She plans to test whether innovation at the firm level leads to the same impact on trade flows as has been found for higher income countries.

Carolina truly excels in research. Her job market paper is elegant. She starts with a simple idea--one that seems straightforward, and is fundamental to our understanding of international trade. She explores the data to see if the evidence supports the idea. She then introduces the idea theoretically, in a rigorous, but straightforward way, incorporates a novel and sophisticated way of estimating her key variable, and demonstrates both theoretically and empirically why her idea matters. Her second paper demonstrates a keen ability to recognize remarkable empirical patterns in economic development and trade, and design creative models to explain why another, seemingly unrelated remarkable pattern, might indeed explain them. Finally her third paper shows her ability to test a long-debated issue in a completely novel way that sheds light and moves the debate forward. I expect that she will be a highly productive researcher, and will make significant contributions to theoretically-based empirical trade.

When it comes to teaching, Carolina is absolutely terrific. She has a first-rate grasp of both theory and empirical methods in economics, and excels in communicating to students at the undergraduate, masters, and Ph.D. levels. She has a wide experience in teaching, as the TA for first year MA courses in International Trade, Economic Development, and my second year seminar in Empirical Trade. At the undergraduate level she has been a TA for Macroeconomics, Econometrics, and the Economics department's senior honors thesis program, which involves anywhere from 6-12 theses each year. As instructor for my empirical trade seminar, she is taking on a challenging course. Students read and discuss professional papers focused on empirical trade issues, learn new econometric techniques, and produce their own empirical research paper. Carolina has already introduced her own innovations in the choice of topics, readings, and econometric tools covered. As a teacher, she is clear, engaging and highly effective. Students consistently give her great reviews and so do we professors!

I give Carolina my highest recommendation. She is a truly remarkable candidate, and will make a terrific colleague. The words that I continually think of to describe her are "far beyond the top of the class" and "the best research assistant/coauthor one could wish for." I encourage you to give her serious consideration. I would be very happy to provide additional information if that will be helpful. Please feel free to contact me.

Best wishes,

Judith M. Dean

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November 5, 2016

RECOMMENDATION FOR MS. CAROLINA PAN

It's a real pleasure to recommend Carolina Pan for any competitive teaching and/or research position. I have known her for four years as a student in the Brandeis Ph.D. program. She has been my teaching assistant and I am now a member of her thesis committee.

Carolina is an exceptional applied economist. She is comfortable with state-of-the-art models and connects significant innovations in modeling with sophisticated econometric analysis. She is also versatile, with wide knowledge of macro- and microeconomics, excellent skills for working with large datasets, and interests that stretch well beyond trade to technology and development.

Carolina's job market paper focuses on the Eaton-Kortum 2007 (E-K) trade model and an innovative extension that links it with another, unpublished Eaton-Kortum 2010 paper that models an innovation process that can, in turn, produce international productivity distributions. This powerful combination of models allows Carolina and her coauthor to argue that the productivity distributions that are central to the E-K model vary across countries not only in terms of average levels of national productivity (as E-K assume), but also in terms of the dispersion of firm-level productivities around each national mean. That second moment has important implications for trade and her econometric estimates suggest that it adds significant explanatory power to gravity equations of trade flows. Admittedly the exposition of this idea could be further improved (for example, the label "comparative advantage" for the relevant variable is misleading), but she has produced a theoretically interesting and empirically significant addition to a crowded literature—no mean feat for a PhD thesis.

Her other essays also address interesting trade and technology issues and demonstrate a healthy curiosity and good nose for problems. A second essay argues that transport costs alone cannot explain the large drop-off in trade among countries separated by wide distances, hinting at the importance of culture, personal networks, and other dimensions of social connections. She uses a unique natural experiment, the blockade of a bridge connecting the capitals of Argentina and Uruguay during the "Pulp Mill Conflict" of 2006-2010, to isolate the true size of the distance effect—in other words, to determine the scale of what is left to be explained by close relationships among neighboring countries. A third essay in turn probes the determinants of technology across economies with a large patent database.

In sum, Carolina is smart, innovative, hard-working, and is very well trained in a variety of methodological tools. And she is a delightful person—outgoing, interested, and a terrific teacher—a favorite of students and colleagues. I recommend her very enthusiastically.

Sincerely yours,

Peter A Petri

Brandeis University

INTERNATIONAL BUSINESS SCHOOL

Waltham, MA, November 11, 2016

Dear Members of the Search Committee:

I am delighted to write a letter of recommendation on behalf of Carolina Pan, a PhD candidate in International Economics and Finance at Brandeis University, who is applying to a position at your institution. I first met Carolina in the fall of 2010 when she arrived at Brandeis to start the PhD. During her first semester at Brandeis she worked as my research assistant, and since then I have seen her presenting her research numerous times at internal seminars. We also talk regularly, since I am a member of her dissertation committee. Thus, I am in a good position to comment on her research and her abilities. Before I comment on her research, let me state that she is one of the best students we have in the job market this year. She is also the best candidate specializing in international trade since 2010 (the year I moved to Brandeis). I encourage you to give strong consideration to her application. She would be a great addition to any school needing a trade person and would increase diversity. She gets my strongest recommendation.

Carolina is an excellent student, confident in herself, creative and very smart. She is the smartest student of her class, and unlike many graduate students who work on "safe" projects, Carolina has taken risks by focusing on ambitious research projects that require a significant amount of creativity and data collection. Her first research paper "Distance and Trade: A Natural Experiment in South America" uses the blockade of an important bridge that connects Argentina and Uruguay as a natural experiment to estimate distance elasticities in a gravity model. Economists use the gravity model (taken from physics) to explain the amount of international trade between countries based on their relative sizes, trade barriers, and distance. Several scholars have used the gravity model to estimate the effect of distance in international trade, but

their estimates appear too large to be considered reliable. These studies usually suffer from two problems: (1) distance is not measured correctly and (2) endogeneity problems. Carolina uses a unique data set that she herself collected at the United Nations Economic Commission for Latin America and the Caribbean (ECLAC) in Santiago, Chile. The data set has detailed information on distance by different ways of transportation (land, sea, and air) for a group of South American countries. Since the blockade of the bridge forced people to find alternative routes, the distance measure varies not only by country but also by time, which is remarkable. In addition, endogeneity concerns are eliminated since the blockade was exogenous and unrelated to trade. As expected, Carolina finds distance elasticities that are much lower than what previous studies had found and shows the magnitude of the bias by estimating a traditional gravity model. In my view, this is a very nice paper and shows the importance of using exogenous changes in the economic environment to study the causal effect of one variable on another. I consider this paper completed and ready for submission to an economics journal.

Carolina's job market paper, titled "Ideas and Trade" and coauthored with Fernando Yu of Harvard University, focuses on the relationship between international trade and innovation. There is a significant amount of empirical work studying the effects of international trade on technology transfer using country-level, industry-level or firm-level data. The results are generally mixed, although the consensus is that international trade facilitates the transfer of technology across countries. What has been less studied is the effect of innovation and technological change on international trade. Carolina argues that this is a very important question because even though countries may be able to obtain new technologies through international trade, it takes time for these transfers to materialize and increase productivity and economic growth. Similarly to her first paper, Carolina uses a novel approach and a new data set on patents since 1836 that she has collected. The first contribution of the paper is to show that there is a U-shaped relationship between sectoral technological specialization and income per capita: countries with high income per capita tend to innovate in more sectors but after a certain threshold of income countries tend to specialize in fewer sectors. She then uses a highly influential paper by Eaton and Kortum to show that countries differ not only on their overall level of technology (which we suspected to be the case), but also in how these technologies are

distributed across sectors. I consider this paper to be near completion and expect Carolina to publish it in a top refereed journal in economics.

Carolina's third paper is titled "Unveiling the Pattern of Technological Diversification," which studies the patterns of specialization in technology using the large data set on patents she constructed. This paper is work in progress but I am confident it will be completed by early 2017, which would allow her to graduate by May 2017.

I also would like to mention that Carolina also has plenty of teaching experience. She has been a TA for a variety of courses, including international trade, econometrics, economic development, and macroeconomics. She has also taught the course Empirical Trade Policy and Analysis at the Master in International Economics and Finance at Brandeis.

Finally, I would like to say that Carolina is very friendly, nice, easy going, and can communicate in both English and Spanish effectively. I strongly recommend her.

Please don't hesitate to call me or email me if you need more information about Carolina.

Sincerely,



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