Title

Impacts of Trade on Wage Inequality across the United States: Analysis Using Matched Employer-Employee Data

Author

Cooke, Abigail Montague

Publication Date

2014

Peer reviewed|Thesis/dissertation

UNIVERSITY OF CALIFORNIA

Los Angeles

Impacts of Trade on Wage Inequality across the United States:

Analysis Using Matched Employer-Employee Data

A dissertation submitted in partial satisfaction of the

requirements for the degree of Doctor of Philosophy

in Geography

by

Abigail Montague Cooke

2014

ABSTRACT OF THE DISSERTATION

Impacts of Trade on Wage Inequality across the United States:

Analysis Using Matched Employer-Employee Data

by

Abigail Montague Cooke

Doctor of Philosophy in Geography

University of California, Los Angeles, 2014

Professor David L. Rigby, Chair

The research presented in this dissertation examines the impacts of trade from low-wage countries on U.S. labor markets. Analysis explores how imports from low-wage countries influence the wages of workers with high- and low-levels of education and how such trade may be related to growing wage inequality. Linkages between import competition and low-wage imports at the national level are extended to individual census regions to provide some of the first sub-national data linking trade and wage inequality. Standard models of trade impacts by education-skill categories also are extended to capture the influence of task-based characteristics of work. Finally, the effects of import competition from low-wage countries on the likelihood of plant closure are examined. Engaging with the most recent theoretical models of trade, the empirical analysis presented in this dissertation uses detailed microdata from the U.S. Census

Bureau. Those data are used to link individual workers to manufacturing plants and firms. The resulting employer-employee files are appended with data on the task characteristics of different occupations and with measures of import competition built-up from individual trade transaction data. The result is one of the most comprehensive datasets yet built connecting measures of trade to the characteristics of jobs, workers and business establishments spanning the years 1992-2007. Analysis of these data yields insights into the socially and spatially uneven consequences of trade. This dissertation finds that low-wage import competition is significantly related to increased inequality, driving down wages for workers with low levels of formal education and driving up wages for workers with high levels of education. The results indicate that import competition increases the nonproduction worker share of total wages within establishments, another measure of wage inequality related to differences in worker skills/education. It also reveals that the relationship between wage inequality and low-wage import competition varies substantially across U.S. regions. Furthermore, this dissertation finds that task intensity measures of routineness, complexity, and interpersonal interaction in a worker's occupation significantly mediate the effect of low-wage import competition on workers' wages. It also finds that low-wage import competition significantly raises the likelihood of manufacturing plant closure.

The dissertation of Abigail Montague Cooke is approved.

John A. Agnew

William A. Clark

Ronald L. Rogowski

David L. Rigby, Committee Chair

University of California, Los Angeles

2014

To Nicholas,

and to my family

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGMENTS

David L. Rigby was the PI on the Census Research Data Center (RDC) project of which this dissertation research was a part. His guidance was essential to the project and to this dissertation. His input was particularly helpful in writing Chapter 5. Tom Kemeny was a Co-PI on the RDC project and his input was particularly helpful in writing Chapter 4. Both Rigby and Kemeny have also provided endless encouragement and advice on the dissertation process and beyond. I am grateful to them both.

Thanks are warmly given to a host of people at UCLA who have made finishing this dissertation possible: my committee, John Agnew, Bill Clark, and Ron Rogowski; mentors and friends among the Geography Department faculty: in particular, Eric Sheppard, Helga Leitner, Judy Carney, and Marilyn Raphael; friends and colleagues among my fellow graduate students, in particular my writing group: Alice Huff, Timur Hammond, Luis Alvarez, Tom Narins, Dylan Conner, and Diane Ward; and not least to the Geography Department staff, without whom there might be a lot of big thoughts but no real action: in particular, Kasi McMurray, Kristina Magpayo, Rebecca Goodine, and Brian Won.

Special thanks to my very supportive and loving family for encouragement and reality checks in equal measure. I am immensely grateful to Nicholas Lustig for his encouragement, enthusiasm, sharp editorial eye, and humor.

UCLA Graduate Division, The Society of Women Geographers, The John Randolph Haynes Foundation, and The UCLA Institute for Research on Labor and Employment are gratefully acknowledged for funding various stages of research that contributed to this dissertation. A grant awarded by the National Science Foundation to David L. Rigby and Tom Kemeny funded access to the RDC for the entire RDC project (Grant GSS-0961735).

The research in this dissertation was conducted at the California Census Research Data Center at UCLA. Special thanks are due to Frank Limehouse and Arnie Reznek for help with clearing the output from this project and to Kevin McKinney for helping me get on my feet in the RDC.

Any opinions and conclusions expressed herein are those of the author and do not necessarily represent the views of the U.S. Census Bureau. All results have been reviewed to ensure that no confidential information is disclosed.

VITA

EDUCATION

M.A., Geography, University of California, Los Angeles, 2009

B.A., History, Yale University, 2001

EMPLOYMENT

Research Data Center Administrator, CCRDC-UCLA, The U.S. Census Bureau, Los Angeles, CA, 2010-2014

Teaching Fellow, Department of Geography, University of California, Los Angeles, CA, Summers 2011-2013

Senior Research Specialist, Princeton Institute for International and Regional Studies, Princeton University, Princeton, NJ, 2005-2006

Research Assistant, Office of Population Research, Princeton University, Princeton, NJ, 2004-2005 and 2002-2003

Lecturer, Department of Foreign Languages, Khon Kaen University, Khon Kaen, Thailand, 2003-2004

PUBLICATIONS

Gates, G.J. and A.M. Cooke. 2011. "Census Snapshot: 2010." Reports on the demography and geography of same sex couples in the fifty U.S. states and Puerto Rico for The Williams Institute, UCLA School of Law.

Cooke, A., T. Lim, P. Norlander, E. Shih, C. Tilly (Eds) 2011. "Special Issue: Labor in the Global South – A Search for Solutions." *Journal of Workplace Rights*. 15(3-4)

Cooke, A.M., S.R. Curran, A. Linton, A. Schrank (Eds) 2008. "Special Issue: Trading Morsels." *Globalizations* 5(2).; also published as Curran, S.R., A. Linton, A. Cooke, A. Schrank (Eds) 2009. *The Global Governance of Food*. Abingdon, UK and New York, NY: Routledge.

Curran S.R. and A.M. Cooke. 2008. "Unexpected Outcomes of Thai Cassava Trade: A Case of Global Complexity and Local Unsustainability." *Globalizations* 5(2): 111-128.

Cooke, A.M. 2001. "Humorous Reflections on Laughing Records." *Association for Recorded Sound Collections Journal*, 32(2): 232-239.

Chapter 1

Introduction

The research presented in this dissertation examines the impacts of trade from low-wage countries on U.S. labor markets. Analysis explores how imports from low-wage countries influence the wages of workers with high- and low-levels of education and how such trade may be related to growing wage inequality. Linkages between import competition and low-wage imports at the national level are extended to individual census regions to provide some of the first sub-national data linking trade and wage inequality. Standard models of trade impacts by education-skill categories also are extended to capture the influence of task-based characteristics of work. Finally, the effects of import competition from low-wage countries on the likelihood of plant closure are examined.

Engaging with the most recent theoretical models of trade, the empirical analysis presented in this dissertation uses detailed microdata from the U.S. Census Bureau. Those data are used to link individual workers to manufacturing plants and firms. The resulting employer-employee files are appended with data on the task characteristics of different occupations and with measures of import competition built-up from individual trade transaction data. The result is one of the most comprehensive datasets yet built connecting measures of trade to the characteristics of jobs, workers and business establishments spanning the years 1992-2007. Analysis of these data yields insights into the socially and spatially uneven consequences of trade.

The twentieth century saw substantial shifts in patterns of income distribution. Income inequality was very high at the beginning of the century, but it narrowed dramatically starting around the First World War. By the time of the Second World War, income inequality was comparatively low and stayed that way until the late 1970s. The postwar period was one of economic growth during which time the increasing returns from growth and productivity gains were shared in such a way that there was very little growth in overall wage inequality. However, by the late 1970s, inequality started growing rapidly. By some measures, at the dawn of the twenty-first century, the U.S. had returned to levels of inequality in income not seen since the 1910s and 1920s (Atkinson, Piketty, and Saez 2009; Piketty and Saez 2003). This growth in inequality has continued into the new millennium and has become a source of widespread concern and discussion.

Trade patterns have also seen substantial changes over the last century. High and growing volumes of international trade at the opening of the twentieth century gave way to lower volumes between the World Wars. Since then, with shorter periods of slow growth, the overall trend has been one of growing freight volumes and increased world integration via trade, notably including a great deal of trade between advanced economies. More recently, over roughly the past three decades, world trade volumes have continued to increase but with substantial growth of trade between advanced and developing economies. Imports into the U.S. from low-wage countries have grown much faster than imports from the rest of the world in the past few decades and today the U.S. imports more from China than from any other country.[1]

Theory linking trade and wage inequality has been discussed since at least the 1940s when Stolper and Samuelson (1941) published their theorem on the uneven return to the factors

[1] U.S. Census Bureau, Foreign Trade Division, "Top Trading Partners" http://www.census.gov/foreign-trade/statistics/highlights/top/top1312yr.html#imports. Accessed 3/16/2014.

of production as relative prices change due to trade. Building from the Heckscher-Ohlin model of trade, they argued that as countries specialize production towards the sector that used the abundant production factor most intensively, the wages paid to the abundant factor should increase relative to the wages paid to the scarce factor. For example, in the basic Heckscher-Ohlin two-country world, where one country has a lot of high-skilled labor and relatively little low-skill labor and the other country has the opposite relative factor endowment, according to the theory, two things should happen when these countries trade. First, the countries should specialize production in the sector that uses their abundant resource most intensively. So, the high-skill abundant country should make more of the type of products that require lots of high-skill labor to produce. Second – and this is the contribution from Stolper-Samuelson – the relative returns to the different factors of production should shift in favor of the abundant factor. So, in the high-skill abundant country, high-skill workers should see a relative rise in wages compared to their less-skilled neighbors. The opposite should hold in the low-skill abundant country. The inequality implications of the Stolper-Samuelson theorem for a country like the U.S. are that inequality should rise as trade with low-wage countries increases.

Interest in the connection between trade and wages has not diminished since Stolper-Samuelson. This relationship itself has been shifting as world trade and inequality patterns have changed over time. Largely in response to observed changes in world trade, changes in the theory and data available make possible new understandings of how trade and inequality relate. The changing literature is reviewed in Chapter 2 in more detail, but the basic arc is as follows. In the 1990s and into the early 2000s, numerous empirical tests of inequality effects of trade found underwhelming evidence for a strong role for trade in driving wage differentials in the U.S. This supposed consensus on the question lead to critiques of the Heckscher-Ohlin framework and Stolper-Samuelson mechanisms and the development of alternate explanations for the rise of inequality, namely the uneven benefits from new technologies in the workplace. However, the lackluster empirical results also led to innovation in extending the Heckscher-Ohlin framework and newer approaches to modeling the effects, including accounting for intra-industry trade in intermediate goods, variety in products, and trade in tasks. It has also lead to new developments in trade theory, moving further away from the Heckscher-Ohlin framework to consider heterogeneity among firms, product variety, and increasing returns to scale within firms. Using these updated theoretical insights, more recent empirical tests of trade effects utilize datasets on firms, employees, and trade transactions that is more detailed than data available in the past. Interest in this question has not only endured but flourished over the past decade.

This dissertation contributes to the recent literature on trade effects in particular by bringing detailed microdata on U.S. workers, establishments, firms, and trade transactions to bear on recent theoretical models. The granularity and breadth of the data allow for several approaches not possible with other U.S. data. These include simultaneously controlling for worker and establishment/firm characteristics in estimated wage models, examining the varying effects on workers with different education levels and task characteristics, and observing regional variation in the trade-wage relationship. Because there are differences in the approach made possible by the microdata, the research in this dissertation extends and complements some of the most recent studies, perhaps building towards a new consensus on the effect of trade on wages.

This dissertation also contributes to the larger study of inequality. Attention to high and growing inequality in the U.S. and other countries is particularly intense right now. It is discussed in the public sphere and the media, in policy circles and across the Academy. Within geography, globalization's effect on inequality was recently identified as one of the strategic questions the discipline should take on (National Research Council 2010).

Our understanding of the troubling consequences of inequality is growing. There are concerns that inequality hurts social and economic mobility both for individuals and subsequent generations, hinders overall economic growth, and is tied to and exacerbates other social and economic concerns such as poverty and health. The proliferation of attention to the causes and consequences of inequality is important. This dissertation contributes to a piece of the larger puzzle, focusing on how trade with low-wage countries is related to wage inequality in the U.S. Understanding the nuance in this relationship allows for potentially smarter policy interventions that could ideally preserve the gains from trade and mitigate the attendant harm, or at least cushion the blow on the people and places that are being harmed by trade.

The plan for the dissertation is as follows:

As mentioned above, the research on trade and wages is a broad literature with a long history. Chapter 2 provides an overview of this literature. It starts with a summary of the major trade theory developments, beginning with neoclassical models, then turning to monopolistic competition models that were developed later, and finally examining some of the recent updates to the factor proportions framework. Next, the main theoretical implications for wage inequality are discussed with a focus on the two generations of factor proportions frameworks. This section includes a brief review of the early empirical research that prompted the critiques of the earlier version of the framework and lead to the later innovations in the theory. The next section highlights recent empirical studies of trade and wage inequality. A discussion of the subnational patterns of trade effects follows. This chapter closes by positioning the dissertation's analytical research in the literature and highlighting the key contributions.

The aim of Chapter 3 is to examine the connection between trade and wage inequality in the U.S. during the period 1990-2007. Specifically, it estimates the relationship between low-wage import competition and inequality between the wages for groups of workers with high- and low-levels of education. The data used in this chapter allow for several advantages over previous studies: recent data covering the period of rapidly growing imports from low-wage countries; construction of import competition measures that capture trade from low-wage countries; ability to use education levels in place of less reliable and detailed indicators of worker skill; inclusion of worker and establishment characteristics made possible by linking workers and plants; observation of regional variation in the relationship; panel construction for some models; and a dense sample that includes hundreds of thousands of observations.

Briefly, this chapter finds that low-wage import competition is significantly related to increased inequality, driving down wages for workers with low levels of formal education and driving up wages for workers with high levels of education. Further, results indicate that import competition increases the nonproduction worker share of total wages within establishments, another measure of wage inequality related to differences in worker skills/education. This chapter also reveals that the relationship between wage inequality and low-wage import competition varies substantially across U.S. regions. These findings extend previous findings and provide a complementary account to some of the most recent empirical research on trade and wages, perhaps building towards a new consensus on the role of trade in contributing to inequality in the U.S.

Chapter 4 responds to recent conceptions of production and trade that involve increasingly fine-grained divisions in production processes down to the level of individual tasks. The concept of trade in tasks (e.g., Baldwin 2006; Blinder 2006; Grossman and Rossi-Hansberg 2006) reveals how previously untradeable economic products, such as many services, can now be delivered across international borders. It also reveals how previous thinking on who would be most affected by increasing trade is increasingly outdated. Education and non-manual labor no longer provide automatic protection from international competition; the characteristics of production tasks are arguably better predictors for today's world of cheap and fast conveyance of goods and information. Briefly, the task trade literature argues that it is possible to offshore tasks that are relatively routine, meaning tasks that can be described easily and clearly in codifiable language. More complex tasks (those involving creativity, problem-solving, or judgment-based decisions) and tasks involving interpersonal interaction are more costly to coordinate and offshore. The intensity of these task characteristics (routineness, complexity, and interpersonal interaction) in different occupations means that certain occupations are more vulnerable to direct offshoring. This chapter argues, consistent with recent research by others (e.g., Rigby et al. 2014, Ebenstein et al. 2013), that workers are more vulnerable to import competition from low-wage countries if the tasks they perform have these offshoring-vulnerable characteristics and yet remain onshore. This chapter examines the relationship between low-wage import competition and the wages of workers with these different task characteristics that make their jobs more or less vulnerable to task trade.

The findings in this chapter are that task intensity mediates the effect of low-wage import competition on workers' wages. It shows that import competition from emerging economies is associated with lower wages for workers with highly routine jobs and workers with jobs that have low complexity. It also finds that workers in jobs with low routineness and high complexity earn higher wages when there is greater low-wage import competition. Together, these effects on high- and low- task intensity workers have a polarizing influence on wages along a task-intensity continuum, rewarding workers at one end of the spectrum and penalizing workers at the other end. The trade and wage relationship mediated by interpersonal interaction task intensity is not linear, with high and very low level of interpersonal interaction related to increased wages, but medium-low levels associated with decreased wages. These results suggest that sector and education level are no longer the only characteristics important for more fully understanding the relationship between trade and wages.

Chapter 5 broadens the focus slightly to look at the low-wage import competition impacts on plant closures. The trade theory implications operate not only at the level of workers, but plants and firms as well. The primary contribution of this chapter to the literature is the use of a real panel of establishments, addressing concerns that unobserved establishment characteristics might be driving results in previous studies. This chapter also advances the literature by updating the results to capture trade and plant closure dynamics until just before the Great Recession of 2008, with results spanning 1990 to 2007. This period captures the dramatic rise in import competition from low wage countries, as trade barriers have continued to fall and low-wage countries have rapidly industrialized, focusing much of that industrial development in export-oriented sectors.

This chapter finds that increased industry-specific import competition from low-wages countries raises the likelihood of a U.S. manufacturing plant closing down. This finding is robust to several specification strategies and controls for important plant and firm characteristics. These findings also control for unobserved establishment heterogeneity, exploiting a real panel of establishments.

Chapter 6 serves as a short conclusion. It provides a brief summary of the findings and provides some context for them, both in relation to each other and a broader context, in order to better understand the implication of this research.

Bibliography

Atkinson, A. B., T. Piketty, and E. Saez. 2009. Top Incomes in the Long Run of History. *National Bureau of Economic Research Working Paper Series* No. 15408.

Baldwin, R. 2006. Globalisation: the great unbundling(s). Finland: Prime Minister's Office, Economic Council of Finland.

Blinder, A. S. 2006. Offshoring: The Next Industrial Revolution? *Foreign Affairs* 85 (2):113-128.

Ebenstein, A., A. Harrison, M. McMillan, and S. Phillips. 2013. Estimating the Impact of Trade and Offshoring on American Workers Using the Current Population Surveys. *Review of Economics and Statistics*.

Grossman, G. M., and E. Rossi-Hansberg. 2006. The rise of offshoring: it's not wine for cloth anymore, 59-102.

National Research Council. 2010. *Understanding the Changing Planet:Strategic Directions for the Geographical Sciences*: The National Academies Press.

Piketty, T., and E. Saez. 2003. Income Inequality in The United States, 1913-1998. *The Quarterly Journal of Economics* 118 (1):1-39.

Rigby, D., T. Kemeny, and A. Cooke. 2014. Import Competition from Low-Wage Countries and Rising Wage Inequality in the United States. Working Paper available from authors.

Stolper, W., and P. A. Samuelson. 1941. Protection and Real Wages. *Review of Economics and Statistics* 9:58-73.

Chapter 2

Trade and Inequality in the Literature

2.1 Introduction

The goal of this chapter is to provide an overview of the literature on trade and wages. The discussion of this relationship in the literature is broad, has a long history, and is on-going. Early theoretical contributions predicted that there should be a causal relationship from trade to wage inequality outcomes, but empirical evidence of this relationship has been elusive. As the volume of trade and the magnitude of wage inequality have grown in the U.S. and around the world, the stakes of this debate have grown as well, driving both theoretical developments and a proliferation of increasingly sophisticated empirical studies.

To summarize the key points in the theoretical and empirical work on trade and wages, the rest of this chapter proceeds as follows. The first section gives an overview of the main trade theory developments, beginning with neoclassical models, then turning to monopolistic competition models that were developed later, and finally examining some of the recent updates to the factor proportions framework. The second section provides an account of the main theoretical implications for wage inequality from the old and new factor proportions frameworks. This section also reviews some of the early empirical research that prompted critiques of the old factor proportions framework and spurred later innovations in these models. The next section highlights recent empirical studies of trade and wage inequality. This is followed by a discussion of the research on the subnational effects of trade and the implications for wages. The final section briefly positions the research reported in the analytical chapters of this dissertation, highlighting their key contributions to the literature.

2.2 Trade Theories

Two broad visions of trade theory seek to provide frameworks for understanding historical and contemporary flows of commodities between countries. These theoretical camps have not remained static, but rather have shifted over time largely in response to how trade has developed. The earliest trade theory envisages a world in which different places produce different commodities. Initial understanding of a crude, product-based spatial division of labor had to do with geographical variations in climate and the uneven distribution of natural resources. Perhaps at first local, then regional and then international networks of supply and demand developed over time as different peoples became exposed to exotic commodities. The spice trade offers an early example. However, technological differences also contributed to the growth of trade. The galleon trade set in motion by Columbus's encounter with the people living in the gold and silver-rich lands in the Americas was shaped by the geographical variation in precious metal deposits (e.g., the Potosi mines), but was motivated by European demand for Chinese-manufactured, technologically advanced products such as porcelain and silks (Mann 2011). As manufacturing developed in concert with technological developments in transportation that made the distribution of industrial-scale production feasible, what made places different increasingly had to do with the distribution of capital, skilled workers, and manufacturing technology and infrastructure. Geographical differences in natural endowments and in the character of manufactures motivated Ricardo's explanation of trade theory based on comparative advantage.

From early models of comparative advantage a series of refinements and reconsiderations have produced several broad theories of trade. I briefly describe three main strands of trade theory that might be connected to the history of major developments in trade over the past century. These strands of trade theory are Heckscher-Ohlin models, monopolistic competition models, and new factor proportions and task trade models. Each is summarized below.

2.2.1 Heckscher-Ohlin Factor Proportions Framework: North-South Trade

The Heckscher-Ohlin (H-O) model is strongly rooted in Ricardian comparative advantage ideas. It was developed for a world where trade was dominated by exchange of final goods and where specialization of production in countries occurred at the sectoral level. The basis for comparative advantage was geographical differences in factor endowments and the differential use of these specific factors across industries. The key prediction of the H-O model is that relatively open trade allows countries to specialize in the production of those commodities that use their abundant factors of production intensively. The H-O model was important as an extension of Ricardo because it envisaged a world with two countries, two goods, and crucially two inputs, such that the gains and potential costs of trade might vary across those who controlled the different inputs.

For the purpose of tying these models to the question of income inequality, we can think of two factors, high-skill and low-skill labor (though the implications are similar for capital rents, or returns to any other factor involved). A country specializes in the production of goods that intensively use its abundant factor. So a country like the U.S., which is relatively abundant in high-skill labor, will tend to specialize in high-skill intensive production. The low-skill labor abundant country will specialize in low-skill intensive production. This is known as a factor proportions framework.

The simplified world of the factor proportions framework relates to what is thought of as Global North-Global South trade. The North-South terminology grew out of dependency theory and world systems theory explanations for the interconnections that produce uneven development, wealth, and power among countries (e.g., Chase-Dunn and Grimes 1995; Frank 1966; Wallerstein 1979). Global North countries are advanced industrialized economies, often colonial or former colonial powers, with generally higher levels of technological sophistication, education, and remuneration for labor. In the H-O two country world, the high-skill labor abundant country would be a Global North country. Global South countries are less wealthy and less industrialized, often colonies or former colonies, with generally lower levels of technological sophistication, education, and average wage levels. In the H-O world, the low-skill labor abundant country would be a Global South country. Today North-South is used as shorthand for the trade patterns laid over centuries, heavily conditioned by colonialism, with a generalized pattern for Northern exports of capital, skill, and high-technology intensive manufactured goods and Southern exports of raw materials and low-skill labor intensive goods. Key to North-South trade is the different factor endowments between trade partners.

2.2.2 Monopolistic Competition: East-West Trade

Around the 1970s, theorists noted that an increasing amount of trade was actually occurring between places with very similar factor endowments. With the previous models of trade predicated on differences between places motivating trade, this presented a puzzle. We sometimes characterize the trade of this period as East-West trade, with a significant proportion of world trade occurring between advanced industrialized countries that made similar types of things and had similar factor endowments. There was still a great deal of trade in finished goods, but increasingly there was also trade in intermediate goods or parts. This kind of trade allows for different parts of the production process of a single finished product to be located far apart, and for specialization to occur within industries as well as between them.

Building from established ideas on product variety and monopolistic competition (e.g., Dixit and Stiglitz 1977), Krugman (1979) advanced a theory of trade not based on comparative advantage and the differences between places discussed in the previous section. His monopolistic competition model featured economies of scale, product variety, and heterogeneous demand within countries. In the simplified world imagined in these models, the advantage of trade comes from cheaper production made possible by economies of scale as production within firms increases. As firms increase their production output to meet demand for specific versions of products, any variety in taste for other versions of that product among a country's population can be met by international trade. This model of trade fit the dominant East-West patterns of trade observed at the time. It also contributed to the development of the heterogeneous firms literature, which focuses on how productivity differences across firms relate to trade (e.g., Melitz and Trefler 2012).

2.2.3 New Factor Proportions: A Return to North-South Trade

One of the key differences between previous periods and the present is that trade is now dominated increasingly by the exchange of intermediate goods. The substantial decreases in the costs of trade and communications has allowed the increased movement of goods and increased coordination across locations. These changes have seen production processes fragmented into increasingly fine segments located around the world wherever the costs for that segment of the process are cheapest. Trade in intermediate goods has been recognized for a number of years now (for example, Baldwin 2006; Coe et al. 2004; Dixit and Grossman 1982; Feenstra and Hanson 1996b; Gereffi and Korzeniewicz 1994; Grossman and Rossi-Hansberg 2006, 2008; Helpman 1984). The recognition of intermediate goods trade was one of the insights that led to important modifications of the basic factor proportions framework.

Along with the recognition of intermediate goods trade, the most recent wave of globalization and the rapid industrialization of many developing countries have prompted calls to return to examining North-South patterns of trade (Baldwin 2006; Grossman and Rossi-Hansberg 2006; Krugman 2008). These calls recognize the increased integration of the global economy since the 1980s and the rise of emerging economies, notably China, as major exporters to much of the developed world. This shift to thinking again about trade in places with very different factor endowments has also contributed to the updating of the factor proportions framework.

One of the primary contributions of these updated versions of factor proportions framework is recognizing that the effects of trade in enhancing specialization within each country are likely not between sectors or industries, but rather within them. For example, Feenstra and Hanson (1996a), taking a basic Heckscher-Ohlin framework as a starting point, describe production as a continuum of intermediate goods, some of which (the ones that require lower-skill intensive labor) can be made outside the home country. Products are produced by a number of tasks along a continuum of skill intensity. Some goods require a lot of high-skill labor, some require a lot of low-skill labor. With trade, countries specialize in making the products that require the abundant factor. A drop in trade costs allows for slightly higher skill products to be shifted to the low-skill abundant country, increasing the average skill-intensity of the products made in both countries.

Another way to extend the H-O framework to the firm or plant level is to assume that plants make bundles of different products, and the input intensity of the plant hints at the mix of products (Bernard, Jensen, and Schott 2006). This allows for a finer-grained analysis of the effects of trade on firms. For example, these arguments predict that the most labor intensive firms are the most susceptible to competition from low-wage, low-skill labor abundant countries. This competitive pressure shifts plants towards more capital and skill intensive manufacturing within and across industries. (This model and the findings of Bernard, Jensen, and Schott are discussed further in Chapter 5.)

Another modification of a basic factor proportions models builds on the focus in Feenstra and Hanson (2001) on intermediate goods trade leading to intra-industry shifts in demand and prices. Ethier (2005) emphasizes high substitutability between low-skill labor and offshoring or imported intermediate goods in the home country. This means that increased imported intermediate goods from low-skill abundant countries act as a substitute for the labor of low-skill home-country workers, lower demand for these workers. Ethier also assumes that equipment complements high-skill labor and can substitute for low-skill labor, with firms able to choose how much equipment to use in production. Thus, firms can choose to use more equipment in place of low-skill labor and that equipment raises the productivity of high-skill workers. Implications for inequality from this and the other models are discussed below.

There are also those who argue that reductions in communications costs have reshaped trade, perhaps even more than transportation costs. The cheapness and speed of moving information allows finer divisions in production fragmentation but also international exchange of things that were previously thought untradeable. Trade in services has garnered attention as a sector previously thought untradeable. Call centers in India are the example that captures the popular imagination, but other services can now be offshored as well (e.g., Jensen and Kletzer 2010).

The term that captures this fragmentation of production across international boundaries that surpasses our previous accounting of intermediate goods is 'trade in tasks.' Tasks are all the incremental steps of the production process necessary to design, test, construct, assemble, sell, and deliver intermediate goods and, eventually, final products.

Though considering trade in tasks has been revelatory in calling attention to trade in services, it also carries important implications for trade in manufactured goods. Task trade suggests a finer level of specialization than even intermediate goods might indicate: specialization at the level of jobs. This insight has helped unsettle our previous ideas of where the impacts of trade might be felt. Recognition of trade in intermediate goods suggested that trade impacts would be felt within industries, not between them. Recognition of trade in tasks suggests that trade impacts will be felt within firms – within factories and offices (Baldwin 2006; Baldwin and Robert-Nicoud 2006; Blinder 2006).

Task trade relies on the ability to integrate and control distributed production networks, involving the efficient and cost-effective coordination of movement of goods, services, and information. There is a special emphasis on the coordination costs, rather than just the local production costs when thinking about how to fragment production. One widely used model was developed by Grossman and Rossi-Hansberg (2008). In their model of task trade, what is traded – or offshored – is determined by weighing the costs of monitoring and controlling workers in another country against the potential savings from lower labor costs in that other country. Coordinating workers from a distance is assumed to be less costly for more routine tasks than for nonroutine tasks. Reductions in trade costs, particularly communications costs, lead to increased offshoring of routine tasks. Extensions of this model include modifications to relax full-employment conditions (Kohler and Wrona 2011). Other approaches to modeling task trade reproduce a basic Heckscher-Ohlin framework by adjusting how the factor endowments of each country are calculated (Baldwin and Robert-Nicoud 2010). In this model, task trade is viewed as the 'shadow migration' of endowments, meaning offshored work is counted as the equivalent of foreign factors moving to the home country, but still being paid the foreign country's wages. Implications of these models are discussed below.

These iterations of trade models have been used widely and for varying purposes. The section below discusses the implications for inequality. Because the focus of this dissertation is on the effects of imports to the U.S. from low-wage countries, I concentrate on the implications from the two sets of models that account for trade between countries with very different factor endowments. What follows is an account of the inequality implications of the basic Heckscher-Ohlin framework and of updated factor proportions frameworks and task trade models.

2.3 Theoretical Predictions on Inequality Effects

2.3.1 Heckscher-Ohlin Stolper-Samuelson

The predictions about inequality within the basic Heckscher-Ohlin framework stem from extensions by Stolper and Samuelson (1941). The relevant implication of the Stolper-Samuelson (SS) model is that trade alters the prices of goods, and this filters back to the demand for the factors as segments of the national economy must now compete with countries with different factor endowments (provided the country also makes the product it is importing (Slaughter 2000; Wood 1995)). This leads to factor price equalization across international borders. However, within the country, the prediction is that trade will help the abundant factor and hurt the scarce factor. The returns to the abundant factor should increase, because demand for the abundant factor would increase with specialization. For example, in a country like the U.S. that has relatively abundant high-skill workers, trade with developing countries will raise the wages of high-skill workers, but depress the wages for low-skill workers. Thus, in countries like the U.S., inequality should increase as the well-remunerated high-skill workers gain relative to the low-skill workers.

The opposite prediction holds in the hypothetical trading partner where there is an abundance of low-skill workers. In that country, specialization occurs in the industries where low-skill labor is the biggest production factor, driving up demand for low-skill workers, and therefore driving the relative rewards for that group of workers as well. Thus inequality between the wages for high- and low-skill labor should decrease.

2.3.2 Critiques of Heckscher-Ohlin and the 1990s Empirical Findings

Empirical work on trade and wage inequality enjoyed a burst of productivity in the 1990s and into the early 2000s, with studies generally falling into two approaches. The first focused on the factor content “embodied” in imports and exports, or, how much skilled and unskilled labor was used to make imports and exports. This was then related to shifts in demand for skilled and unskilled workers (e.g., Sachs and Shatz 1994; Wood 1995). Wood (1994, 1995) finds a relatively large decrease in demand for unskilled workers in developed countries attributable to trade with developing countries (-20% from no trade in 1990), with the Sachs and Schatz (1994) findings going in the same direction but with a much smaller effect. Berman, Bound, and Griliches (1994) and Lawrence and Slaughter (1993) found only a very minor role for trade in reallocating labor. This approach has been roundly criticized, notably by Leamer (1996), partly for not focusing on the relative price changes which come most obviously from the Stolper-Samuelson theorem.

The second approach common during the 1990s focused on more direct tests of SS, looking at the relative price changes between industries characterized by different intensities of skilled or unskilled labor use. Bhagwati (1991) and Lawrence and Slaughter (1993) find no clear evidence of relative price changes. Later, with refinements in methods, other researchers found some support for relative price declines in unskilled intensive sectors in the 1970s but not in the 1980s (Baldwin and Cain 2000; Leamer 1996). Feenstra and Hanson (1999), however, find some support for outsourcing driving inequality increases over the 1980s. The evidence in support of SS from these studies is certainly not overwhelming, and limitations of this approach have been discussed (e.g., (Slaughter 2000).

Partly due to the underwhelming empirical support for trade explanations, alternate hypotheses for observed but unexplained inequality increases developed. One major explanation put forth was that recent technological innovations (e.g., personal computers, microchips, and the Internet) are more useful to highly skilled, highly educated workers (Card and DiNardo 2002; Feenstra 2000). Thus these innovations disproportionately benefit the high-skilled workers, increasing their productivity and their wages relative to less skilled, less educated workers. This hypothesis was known as Skill-Biased Technological Change (SBTC). Though SBTC has garnered a lot of attention, it has not been without its critics (e.g., Feenstra 2000).

A renewed wave of interest in trade explanations spurred innovations in both the theory and the empirical approaches. These new approaches responded to important criticisms of the original formulations.[2] Advances on the basic trade theories have expanded to address heterogeneity within industries, across products, and across firms (e.g., Bernard, Jensen, and Schott 2006; Bernard, Redding, and Schott 2007; Egger and Kreickemeier 2009; Feenstra and Hanson 2001; Helpman, Itskhoki, and Redding 2010; Verhoogen 2008). See Harrison, McLaren, and McMillan 2010 for a helpful review.) The implications from the reworked and updated factor proportions framework follow.

2.3.3 New Factor Proportions and Task Trade Predictions

The substantial updates to the factor proportion theory, outlined above, offer new possibilities for how trade might relate to inequality and where these effects might be visible. Interestingly, these innovations produce predictions broadly in line with the older versions of the Heckscher-Ohlin factor proportions theory, at least for high-skill abundant countries like the U.S.

[2] See Deardorff, Stern, and Baru (1994) for a summary of major contributions and critiques to the Stolper-Samuelson theorem in particular. See Davis and Mishra (2007) for a concise and strongly argued critique. For a useful summary of what the different generations of trade theories can do, see Table 1 in Bernard et al. (2007).

For example, Feenstra and Hanson (1996a) predict increases in wage inequality in both high-skill abundant countries and low-skill abundant countries from trade, as both countries shift slightly up the continuum of skill-intensive production. Note that the prediction about inequality in the low-skill labor abundant country is the opposite of the original SS formulation.

In the new factor proportions models, the factor demand shifts in Stolper-Samuelson are still in operation. However, recall that the production process (within industries, and often now within firms) is fragmenting across countries. The imports from low-wage countries are largely intermediate goods which are being used in the factories importing them. This allows those factories to specialize further in those production tasks at which they are most productive. This should raise the overall productivity of the factory, and rising productivity should increase the wages of all workers in the factory. Thus, high-skill workers should see increased wages from extra demand *and* from increased productivity. But low-skill workers face lower demand, *even if* they get a boost from increased productivity. There is not necessarily a clear theoretical prediction about which of these effects is bigger; the implications for real wages for low-skill workers are not clear. For example, Bernard et al. (2007) allow for consumer taste for variety and overall productivity increases in industries, both potentially leading to reductions in product prices. These reductions could be strong enough to reverse the real wage losses for the relatively scarce factor predicted by Stolper-Samuelson, still operating in their model. However, inequality between high- and low-skill workers is likely to increase, even if the productivity and price changes lead to real wage gains for low-skill workers. This is the prediction of the Ethier (2005) model, in which offshoring and low-skill labor are highly substitutable and equipment and high-skill labor are complementary.

Interestingly, these newer models also predict increased inequality in the low-skill labor abundant countries. This is of particular note because it fits the observed trends in countries like Mexico much better than the original Heckscher-Ohlin prediction that inequality between high- and low-skill workers (the scarce and abundant factors, respectively) would fall in these countries (e.g., Verhoogen 2008).

One of the insights from the task trade literature is that who is affected by this newer, more fine-grained variety of trade is quite "unpredictable" (Baldwin 2006; Baldwin and Robert-Nicoud 2006). High-skill and low-skill might not be the most useful categories anymore. Tasks in developed economies requiring high levels of formal education or training used to be considered safe from international competition, but some of them are now vulnerable to offshoring (Baldwin 2006; Blinder 2006). The key characteristics that determine whether a task can be offshored are only loosely correlated with traditional measures defining "good jobs" and "bad jobs," such as education level or whether a job requires manual labor or not. Task trade makes the effects unpredictable by bringing into question the reliability of previously used categories and makes it difficult to predict who will be affected next as further specialization and finer divisions of labor become possible.

In the Grossman and Rossi-Hansberg (2008) model, the increase in offshoring reduces costs and affects wages in the high-wage (onshore) country in three ways: through terms of trade effects (reducing the price of the imported goods since they are likely made by workers with lower wages); labor supply effects (with demand decreasing for workers with the task trade vulnerable characteristics); and productivity effects (where the onshore workers refocus on higher-productivity tasks).

As with the demand and productivity effects described above in relation to newer factor proportions models, the aggregate effect of these three wage effects is not evident from the model itself. The first two effects suggest that (real) wages for workers in the home country will fall, but the third effect suggests that average wages could rise. Grossman and Rossi-Hansberg are quite optimistic about the likely outcome. The scenario they highlight predicts that wage inequality will decrease with trade in the high-skill abundant country due to increased productivity among all workers. However, the prediction is reversed if their assumption of small countries is relaxed (i.e., the prices of small countries are set on the world market). Then trade acts like an increase in low-skill workers in the high-skill abundant country and therefore low-skill wages are depressed. In this scenario, productivity gains increase the wages for all manufacturing workers, but for low skill workers these gains are overridden by what effectively looks like direct supply increases in low-skill workers. The result is that trade raises the wages of high-skill workers and lowers (at least relatively) the wages for low-skill workers in places like the U.S.

It is also likely that the three effects of offshoring impact workers differentially. Those workers least able to respond to the new challenges of higher productivity tasks could still benefit from rising wages tied to average productivity increases, but are less likely to directly benefit from these shifts in general. This would suggest that inequality between workers most likely to adapt and those least likely to adapt should grow with increased task trade, even if there are general increases in welfare overall. This hunch is confirmed by numerical simulations of the Grossman and Rossi-Hansberg model (Rojas-Romagosa 2010). Nearly all combinations of endowments with a wide range in parameters result in increased inequality in the onshore, high-wage country.[3]

In the Baldwin and Robert-Nicoud (2010) model, with the 'shadow migration' factor measurements, Stolper-Samuelson predictions hold for the home country. This implies that in countries like the U.S., inequality in the wages paid to high-skilled and low-skilled labor should rise with increased offshoring.

The newer trade models contain different mechanisms for affecting returns to workers than the original H-O model. These mechanisms lead to more ambiguous predictions for inequality with the balance of opposing forces not always clear. However, they also lead to predictions that appear to better fit stylized facts in both high-wage countries like the U.S. and the low-wage countries that have become such important trading partners for the U.S. in the past couple decades.

2.4 Recent Empirical Research

The introductory framing of many of the papers on trade and wages generally references early empirical work showing that trade had little to no effect on wages. However, a detailed look back at this empirical work belies the supposed consensus. Even early on there was a diversity of empirical findings (see the introduction of Baldwin and Cain (2000) for a reflection of that diversity in early papers). Crinò (2009) provides a helpful review of the research on the effects of material offshoring on relative labor demand and wage impacts, focusing particularly on studies of the wage gap between skilled and unskilled workers in developed countries.

[3] Rojas-Romagosa (2010) also finds increases in inequality in many numerical simulations in low-wage countries receiving offshored tasks, though in the low-wage countries, offshoring always increases welfare in aggregate.

Several other previous articles and books have also reviewed the empirical results of early studies of trade and wages (e.g., see Feenstra and Hanson 2001 for a review that incorporates critiques and correctives to early studies that presented evidence of only a minor role for trade such as Berman, Bound, and Griliches 1994; Lawrence and Slaughter 1993). Even if the 1990s consensus that trade did not matter is overstated, the proliferation of work on the effects of trade today cannot be mistaken.

Though much of the earlier work (and some of the research even today) relied on a measure of inequality proxied by the ratio between wages paid to nonproduction and production workers, a few studies examine the demand for and wages of workers grouped by educational achievement. In these studies, the evidence suggests that low-education workers are hurt by import competition and high-education workers are helped by it. For example, Ekholm and Hakkala (2006) show that increased offshoring from Sweden to low-income countries decreases demand for workers with lower levels of education (secondary education) and increases demand for workers with higher levels of education (tertiary education). Morrison Paul and Siegel (2001), find that computerization and trade shift demand away from low-education workers and increase demand for college-educated workers in the U.S. – both directly, independent of each other, and with trade seeming to drive additional computerization. They find that the trade effect is smaller than the technological change effect for workers with all education levels. Finally, Rigby and Breau (2008), using matched employer-employee data for Los Angeles in 1990 and 2000, find that trade depresses wages for workers with lower levels of education (less than a high school diploma). They find that skill-biased technological change also hurts low-education workers in 1990, but that the effect is not significant in 2000. In addition, they find that by 2000, the trade effect seems to have crept up the education ladder, significantly depressing the wages of high school graduates as well as those without a diploma. Their work implies that the role of trade in increasing wage inequality is expanding in two senses: trade's effect is growing relative to that of technological change and trade's effect is extending to groups of workers who were previously sheltered from these effects.

Only a handful of studies so far have looked at the relationship between trade and wages beyond the year 2000 in the U.S., a period when low-wage imports has continued to grow at a rapid pace. Firpo et al. (2011) and Ebenstein et al. (2013) trace trends though 2002, both focusing on occupational exposure or vulnerability to trade (based on the occupational characteristics such as routineness of required tasks). Firpo et al. find an increasing role for vulnerability to offshoring in contributing to wage inequality after 1990 and into the early 2000s. Ebenstein et al. also find increasingly large trade effects, particularly after the mid-1990s, decreasing wages for workers with routine jobs. They also find that trade reallocates workers out of manufacturing jobs, with associated decreases in earnings. Autor, Dorn, and Hanson (2012), using U.S. data for 1990-2007,[4] find a host of other negative labor market effects from import competition from China (which is a large portion of imports from low-wage countries into the U.S.). They find that wages in general are depressed across college and non-college education groups, but wages among manufacturing workers are not significantly affected, while wages for non-manufacturing workers are significantly depressed.

A series of recent studies examines how trade and wages are related in developed countries other than the U.S. One such study examines offshoring effects on Danish workers matched to firms for 1995-2006 (Hummels et al. 2011). Hummels et al. find that despite productivity increases within firms, offshoring increases skilled workers' wages but still

[4] The 2007 data they use is actually ACS grouped 2006-2008 data. This is similar to the data approach used in this study. The grouped data helps increase the sample size substantially.

decreases low skill workers' wages. They are not able to test these effects for Danish trade with only low-income countries. However, when they restrict it to trade with only high-income countries, the effects are slightly smaller (p. 30). This suggests that the low-income country offshoring serves to increase the inequality effects. In a separate study, Bloom et al. (2011) find that in European countries in 1996-2007, Chinese import competition lowers demand for low-skilled workers.

Outside Autor, Dorn and Hanson's work on U.S. data, and a handful of recent studies using European data, there has so far been little work on how the relationship between trade and wages has played out after the turn of the millennium (see Feenstra 2010, p. 104).

2.5 Subnational Trade Effects

An important consideration not yet discussed in this chapter is subnational variation in the relationship between trade and wages. Though we think of trade policy as largely restricted to the national scale, states are increasingly courting trade ties and policies mitigating trade effects can operate at the regional scale as well as at the national scale. Exploration of the subnational geography of trade effects is an important, if understudied, endeavor.

The industrial mix of different regions varies substantially across the U.S. Thus, even if a trade effect operates identically across places, the intensity of the lived impacts should vary given the different labor-force compositions region by region. Indeed, some of the recent empirical investigations of the labor market impacts of trade in the U.S. explicitly build measures of trade exposure from employment shares of industries in local labor markets (Autor, Dorn, and Hanson 2013a). Even the basic Heckscher-Ohlin framework, with its focus on industrial shifts, would suggest that industry mix would shape the impact experienced across regions. The potential for regional differences in response to trade is enhanced when we consider that there are distinct regional labor markets within the U.S. While there are not border restrictions on labor within the U.S. as there are across its international boundaries (however unevenly porous they are), the labor markets within the U.S. are not seamlessly integrated. For example, Bernard and Jensen (2000) find that wages within U.S. states are more sensitive to regional employment shocks in any sector than they are to national shocks that are specific to a particular industry (see also Autor, Dorn, and Hanson 2012, p 4).

Regions within countries also do not participate in international markets evenly. Again, industry mix and factor endowments contribute to this unevenness. But the physical geography (e.g., proximity to international borders or navigable waters) and infrastructure investments (e.g., ports) of regions also matter. While much of the research on the role of geography in trade attends to variation across countries (e.g., Limão and Venables 2001), these principles can also apply in some measure to subnational regions as well.

A relatively small strand of the literature deals with subnational geography and trade. For example, Venables and Limão (2002) offer a model of how potential for trade intensity (determined by distance, geography or infrastructure) shape production and trade patterns beyond factor endowment differences across regions. Chiquiar (2008) builds on Venables and Limão's model to show how the intensity of trade across Mexican states (in this case largely determined by geographical proximity to the U.S. border) shapes wages and wage inequality (via a premium for high-skilled workers). Other research explores the impact of trade on intranational disparities between regions (e.g., Rodríguez-Pose 2012; Rodríguez-Pose and Gill 2006; Sánchez-Reaza and Rodríguez-Pose 2002; See Brülhart 2011 for a summary). The findings from these intra-national studies suggest that sector and industry mix play an important role in mediating trade effects. Related is work that shows that variation in trade costs over regions within a country contributes to future regional income growth, even as previous development and growth affect present trade costs (Fratianni and Marchionne 2012).

Much of the empirical work has largely focused on how trade relates to urban growth or agglomeration, or how trade relates to regional economic indicators such as employment, GDP per capita, or wages (see Rodríguez-Pose 2012; Sjöberg and Sjöholm 2004; González Rivas 2007 for recent empirical explorations). As Brülhart (2011) points out, there are no clear and generalizable trade effects obvious in either the theoretical models or the empirical tests. What does seem to matter is the particular geography of the regions with respect to trade accessibility (physical geography, but also economic geography of infrastructure investments) and the existing geography of inequality or uneven development within the country at the time of increased trade liberalization.

This line of inquiry, with its focus on disparities between regional economies or regional labor forces, is slightly different from the work presented in Chapter 3, which focuses on intrapersonal disparities across regions. However, with the focus on the importance of the geography of industry, trade-accessibility, infrastructure, and inequality in shaping the outcomes of regions as they interact with the global economy via trade, this stream of the literature is an important reminder for how the outcomes for interpersonal inequality might also vary regionally.

A different stream of literature interested in the subnational variation in trade effects looks at the vulnerability of different regions to trade competition based on the industrial or occupational mix. An early example of this type of work is Borjas and Ramey's (1995) study of how import competition affects both concentrated and competitive industries differently.[5] They find that the low-education workers in concentrated industries with foreign import competition face lower wages than industries that have more firms competing with each other. They demonstrate the aggregate impacts of this across cities in the U.S., finding that these industrial mix differences help account for the differences in skill premia across cities from the mid-1970s through the 1980s.

In addition to the older studies, there has been recent work exploring how the industry and occupational mix varies across regions in the U.S. and how that shapes the influence of international markets on regions.[6] First, Silva and Leichenko (2004) develop a series of exchange-rate price measures (and industrial structure measures) which they use to observe the effects of changes in the prices of imports and exports on local labor markets. They find significant differences in how trade affects regional income inequality across the U.S., increasing inequality within some regions, decreasing it in others, and driving the fortunes of states in one place relative to those in other regions.

Second, McLaren and Hakobyan (2010) look at the introduction of NAFTA tariff changes to observe the effect of shocks in trade openness on locations and industries. To operationalize this, they use a measure of industry mix across Constant PUMAs.[7] They find the average effect on wages of NAFTA tariff changes is negligible. However for some specific groups of workers the effect is large and significant: a) workers in industries with large tariff drops suffer lower wages; b) workers in locations with jobs concentrated in industries with large

[5] In the Borjas and Ramey article, concentrated industries are industries where production/sales are dominated by a few large firms. An example is the auto industry. Competitive industries are ones where production/sales are shared among many firms, such as the apparel industry.
[6] See also Topalova (2010) for an example of trade liberalization on poverty and differential wages across India and Kovak (2010) for a Brazilian example.
[7] Constant PUMAs are the lowest level of geography available in the Public Use Microdata Sample demographic datasets available from the U.S. Census Bureau that is consistent across multiple Decennial years. These geographic areas vary in size since they are designed to encompass at least 100,000 people.

tariff drops suffer lower wages, even if the workers are not themselves employed in that industry; and c) the effect is stronger for workers without a high school diploma. Wages of workers with college education do not appear to be significantly related to NAFTA's tariff changes.

Third, very recent work along these lines comes from Autor, Dorn and Hanson (2012, 2013a, 2013b), who use occupational and industry mix in Commuting Zones across the U.S. for 1990-2007 to observe the vulnerability of local economies to offshoring of routine jobs (in both manufacturing and services) and import competition from China. They find that in areas with higher import competition from China, there are lower wages, higher unemployment, decreased labor force participation, and increased use of government benefit programs (Autor, Dorn, and Hanson 2012). Interestingly, they also find that it may be possible to separate out the effects of trade and technology changes on wages and labor force dynamics across the U.S. (Autor, Dorn, and Hanson 2013a, 2013b).

More similar to the approach taken in the present article, Chiquiar (2008) looks at the effects of NAFTA across Mexico and finds that wages and skill premia moved differently across Mexico. Overall, inequality increased in Mexico over the 1990s, contradicting basic Stolper-Samuelson predictions that inequality should decrease. However, Chiquiar finds that in the northern states, closest to the border with the U.S. and with the most exposure to international markets, wages rise and the skill premium decreased, which does follow the Stolper-Samuelson prediction. Additionally though, he finds that the wage gains by unskilled workers in the northern states did not carry over to other unskilled workers in the rest of the country. The northern wage gains, responding to trade, contributed to increased wage inequality across the country.

The work of Breau and Rigby (2010) uses Canadian matched employer-employee data to estimate national and regional models of wages for workers grouped by educational attainment. They find that import competition from low wage countries has a negative and significant effect on the wages of workers with low levels of education and increases the wage gap between high- and low-education workers across Canada. When they run the wage models for each province, they find that the impact of import competition is stronger in some provinces than in others, which they attribute to differences in the industrial composition across the country.

There is a great deal of work that could build on the existing research on the subnational patterns of trade effects in general and the relationship between trade and wages in particular. Next I relate some of the specific contributions of this dissertation to the literature discussed in this chapter.

2.6 Contributions to the Literature

2.6.1 Chapter 3: Trade and Wage Inequality, Nationally and Regionally

The research in Chapter 3 contributes to the literature on trade and wages in four specific ways. First, it employs matched employer-employee data, allowing for control of person characteristics and plant characteristics simultaneously, a feature still quite rare in this literature. Second, it uses educational attainment to group workers. This is a better proxy for skill than the production-nonproduction wage ratio so frequently used in earlier studies.[8] Third, it employs a span of years – 1990 to 2007 – that captures the dramatic rise in imports from low-wage

[8] Additionally, educational attainment is arguably a more functional grouping for translating this work to policy and public debate.

countries (particularly driven by China) into the U.S. Finally, it incorporates regional analysis as well as national analysis, revealing a more detailed picture of how these dynamics play out across the country and how these effects vary region to region. It examines differences across regions in interpersonal income inequality (one region with a very unequal wage distribution, another with a relative equal wage distribution) rather than disparities between regions (wealthy regions versus poor regions). The overall approach in Chapter 3 improves upon early work on trade and wages with richer data and improved measures. It also complements the most recently published work using recent U.S. data, by offering a complementary formulation of import competition not based on local industry mix and thus not presuming that local industry mix is a dominant feature of import competition itself.

2.6.2 Chapter 4: Trade and Wages Mediated by Task Characteristics

The research in Chapter 4 contributes to the study of trade in tasks by examining the relationship between low-wage import competition and the wages of workers with different task characteristics that make their jobs more or less vulnerable to offshoring: routineness, complexity, and interpersonal interaction. These particular characteristics and the empirical work focusing on task trade are reviewed in detail in Chapter 4.

This chapter builds on previous research to make several contributions. It observes the wage effects of the impacts of trade on task demand identified by Kemeny and Rigby (2012). It complements the work of Ebenstein et al. (2013) by examining the wage effects of the important task characteristics of interpersonal interaction and complexity, in addition to the effects of routineness. It also complements Baumgarten et al. (2013) and Hummels et al. (2011) by offering a somewhat similar analysis using the case of the U.S. Finally, it includes establishment-level characteristics as control variables on the individual wage outcomes, something not possible without matched employer-employee data and thus not included in much of the previous research (with Hummels et al. 2011 as an important exception).

2.6.3 Chapter 5: Trade and Plant Exit

To this point, this chapter has focused mostly on the effect of trade on groups of workers. However, the implications of this framework can also apply at the level of the establishment or firm as well as the level of the workers. Indeed, Bernard, Jensen, and Schott (2006) offer a modification of the basic H-O framework that suggests thinking about firms as producing bundles of products, which are reflective of the input intensity of each plant. For example, low-skill labor intensive plants make products that require the most low-skill labor intensive work within an industry. However these are the products that low-wage countries have a comparative advantage in producing. Trade liberalization and increasing trade intensity from low-wage countries puts pressure on plants that produce products using low-skill labor intensive techniques. Plants that make a mix of products requiring varying amounts of capital or high-skill inputs should shift their specialization away from the low-skill labor intensive products in their mix. Plants that cannot shift their output towards higher productivity products are likely to close. A summary of the empirical research focusing on plant exit is reviewed in detail in Chapter 5.

The research in Chapter 5 contributes to the plant exit literature in several specific ways. First, it observes exits in more recent years, extending our understanding of these dynamics until just before the Great Recession. This extension not only updates the literature to be more current, but it covers more of the period when imports from low-wage countries expanded dramatically. Second, much of the research on trade and plant exit has used European data. Testing this relationship across different countries is important both for developing a generalized understanding but also for capturing the subtleties in difference across countries, which we should be sensitive to considering the mixed findings from the MNC-plant exit literature. This chapter extends the work done by Bernard, Jensen, and Schott (2006) using U.S. data. Third, this chapter uses a genuine panel of manufacturing plants. This is distinct from the approaches of the recent work of Colantone and Sleuwaegon (2010) that uses a panel of country-industry pairs. It is also distinct from the pseudo-panel used by Bernard, Jensen, and Schott (2006). The real panel form used in the current research should help address concerns about unobserved heterogeneity among plants driving results. Finally, it jointly considers import competition from low-wage countries (following Bernard, Jensen, and Schott 2006) and firm-level characteristics (following Bernard and Jensen 2007) on plant exit. Considering these factors jointly allows for important insights into plant exit.

The following chapter takes up the relationship between low-wage import competition and wage inequality in the U.S.

Bibliography

Autor, D. H., D. Dorn, and G. H. Hanson. 2012. The China Syndrome: Local Labor Market Effects of Import Competition in the United States. *National Bureau of Economic Research Working Paper Series* No. 18054.

———. 2013a. The Geography of Trade and Technology Shocks in the United States. *National Bureau of Economic Research Working Paper Series* No. 18940.

———. 2013b. Untangling Trade and Technology: Evidence from Local Labor Markets. *National Bureau of Economic Research Working Paper Series* No. 18938.

Baldwin, R. 2006. Globalisation: the great unbundling(s). Finland: Prime Minister's Office, Economic Council of Finland.

Baldwin, R., and F. Robert-Nicoud. 2006. Offshoring and globalisation: What is new about the new paradigm? *Graduate Institute of International Studies, Geneva*.

———. 2010. Trade-in-goods and trade-in-tasks: An Integrating Framework. *National Bureau of Economic Research Working Paper Series* No. 15882.

Baldwin, R. E., and G. G. Cain. 2000. Shifts in Relative U.S. Wages: The Role of Trade, Technology, and Factor Endowments. *Review of Economics and Statistics* 82 (4):580-595.

Berman, E., J. Bound, and Z. Griliches. 1994. Changes in the Demand for Skilled Labor within U. S. Manufacturing: Evidence from the Annual Survey of Manufactures. *The Quarterly Journal of Economics* 109 (2):367-397.

Bernard, A. B., and J. B. Jensen. 2000. Understanding Increasing *and* Decreasing Wage Inequality. In *The Impact of International Trade on Wages*, ed. R. C. Feenstra, 227-268. Chicago: University of Chicago Press.

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. 2006. Survival of the best fit: Exposure to low-wage countries and the (uneven) growth of U.S. manufacturing plants. *Journal of International Economics* 68 (1):219-237.

Bernard, A. B., S. J. Redding, and P. K. Schott. 2007. Comparative Advantage and Heterogeneous Firms. *Review of Economic Studies* 74 (1):31-66.

Blinder, A. S. 2006. Offshoring: The Next Industrial Revolution? *Foreign Affairs* 85 (2):113-128.

Bloom, N., M. Draca, and J. Van Reenen. 2011. Trade Induced Technical Change? The Impract of Chinese Imports on Innovation, IT, and Productivity. *NBER Working Paper* 16717.

Borjas, G. J., and V. A. Ramey. 1995. Foreign Competition, Market Power, and Wage Inequality. *The Quarterly Journal of Economics* 110 (4):1075-1110.

Breau, S., and D. L. Rigby. 2010. International trade and wage inequality in Canada. *Journal of Economic Geography* 10 (1):55-86.

Brülhart, M. 2011. The spatial effects of trade openness: a survey. *Review of World Economics* 147 (1):59-83.

Card, D., and J. E. DiNardo. 2002. Skill-Biased Technological Change and Rising Wage Inequality: Some Problems and Puzzles. *Journal of Labor Economics* 20:733-783.

Chase-Dunn, C., and P. Grimes. 1995. World-Systems Analysis. *Annual Review of Sociology* 21:387-417.

Chiquiar, D. 2008. Globalization, regional wage differentials and the Stolper-Samuelson Theorem: Evidence from Mexico. *Journal of International Economics* 74 (1):70-93.

Coe, N. M., M. Hess, H. W.-c. Yeung, P. Dicken, and J. Henderson. 2004. 'Globalizing' regional development: a global production networks perspective. *Transactions of the Institute of British Geographers* 29 (4):468-484.

Colantone, I., and L. Sleuwaegen. 2010. International trade, exit and entry: A cross-country and industry analysis. *Journal of International Business Studies* 41 (7):1240-1257.

Crinò, R. 2009. Offshoring, Multinationals and Labour Market: A Review of the Empirical Literature. *Journal of Economic Surveys* 23 (2):197-249.

Davis, D. R., and P. Mishra. 2007. Stolper-Samuelson is dead: And other crimes of both theory and data. In *Globalization and Poverty*, 87-108: University of Chicago Press.

Deardorff, A. V., R. M. Stern, and S. R. Baru. 1994. *The Stolper-Samuelson Theorem: A Golden Jubilee*. Ann Arbor: University of Michigan.

Dixit, A. K., and G. M. Grossman. 1982. Trade and Protection with Multistage Production. *The Review of Economic Studies* 49 (4):583-594.

Dixit, A. K., and J. E. Stiglitz. 1977. Monopolistic competition and optimum product diversity. *The American Economic Review*:297-308.

Ebenstein, A., A. Harrison, M. McMillan, and S. Phillips. 2013. Estimating the Impact of Trade and Offshoring on American Workers Using the Current Population Surveys. *Review of Economics and Statistics*.

Egger, H., and U. Kreickemeier. 2009. Firm Heterogeniety and the Labor Market Effects of Trade Liberalization. *International Economic Review* 50 (1):187-216.

Ekholm, K., and K. N. Hakkala. 2006. The Effect of Offshoring on Labour Demand: Evidence from Sweden: CEPR Discussion Papers.

Ethier, W. J. 2005. Globalization, globalisation: Trade, technology, and wages. *International Review of Economics & Finance* 14 (3):237-258.

Feenstra, R. C. 2000. *The Impact of International Trade on Wages*. Chicago: University of Chicago Press.

———. 2010. *Offshoring in the Global Economy: Microeconomic Structure and Macroeonomic Implications*. Cambridge, MA: The MIT Press.

Feenstra, R. C., and G. H. Hanson. 1996a. Foreign Investment, Outsourcing, and Relative Wages. In *The Political Economy of Trade Policy: Papers in Honor of Jagadish Bhagwati*, eds. R. C. Feenstra, G. M. Grossman and D. A. Irwin, 89-127. Cambridge, MA: MIT Press.

———. 1996b. Globalization, Outsourcing, and Wage Inequality. *The American Economic Review* 86 (2):240-245.

———. 1999. The impact of outsourcing and high-technology capital on wages: estimates for the United States, 1979-1990. *The Quarterly Journal of Economics* 114 (3):907-940.

———. 2001. *Global Production Sharing and Rising Inequality: A Survey of Trade and Wages*: SSRN.

Firpo, S., N. Fortin, and T. Lemieux. 2011. Occupational tasks and changes in the wage structure. *IZA Discussion Paper No. 5542.*

Frank, A. G. 1966. The development of underdevelopment. *Monthly Review* 18 (4):17-31.

Fratianni, M., and F. Marchionne. 2012. Trade Costs and Economic Development. *Economic Geography* 88 (2):137-163.

Gereffi, G., and M. Korzeniewicz. 1994. *Commodity Chains and Global Capitalism*: ABC-CLIO.

González Rivas, M. 2007. The effects of trade openness on regional inequality in Mexico. *The Annals of Regional Science* 41 (3):545-561.

Grossman, G. M., and E. Rossi-Hansberg. 2006. The rise of offshoring: it's not wine for cloth anymore, 59-102.

———. 2008. Trading Tasks: A Simple Theory of Offshoring. *American Economic Review* 98 (5):1978-97.

Harrison, A., J. McLaren, and M. S. McMillan. 2010. Recent Findings on Trade and Inequality. *NBER Working Paper* 16425.

Helpman, E. 1984. A simple theory of international trade with multinational corporations. *The Journal of Political Economy*:451-471.

Helpman, E., O. Itskhoki, and S. Redding. 2010. Inequality and Unemployment in a Global Economy. *Econometrica* 78 (4):1239-1283.

Hummels, D., R. Jørgensen, J. R. Munch, and C. Xiang. 2011. The Wage Effects of Offshoring: Evidence from Danish Matched Worker-Firm Data. *National Bureau of Economic Research Working Paper Series* No. 17496.

Jensen, J. B., and L. G. Kletzer. 2010. Measuring tradable services and the task content of offshorable services jobs. In *Labor in the New Economy*, eds. K. G. Abraham, J. R. Spletzer and M. Harper, 309-335. Chicago: University of Chicago Press.

Kohler, W., and J. Wrona. 2011. Offshoring tasks, yet creating jobs? *University of Tübingen working papers in economics and finance* 12.

Kovak, B. K. 2010. Regional labor market effects of trade policy: Evidence from Brazilian liberalization. *Research Seminar in International Economics, University of Michigan Working Papers*.

Krugman, P. R. 1979. Increasing returns, monopolistic competition, and international trade. *Journal of International Economics* 9 (4):469-479.

———. 2008. Trade and Wages, Reconsidered. *Brookings Papers on Economic Activity* Spring.

Lawrence, R. Z., and M. J. Slaughter. 1993. International Trade and American Wages in the 1980s: Giant Sucking Sound or Small Hiccup? *Brookings Papers on Economic Activity* (2):161-226.

Leamer, E. E. 1996. In Search of Stolper-Samuelson Effects on U.S. Wages. NBER Working Papers: NBER.

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

Mann, C. C. 2011. *1493: Uncovering the New World Columbus Created*: Random House LLC.

McLaren, J., and S. Hakobyan. 2010. Looking for Local Labor Market Effects of NAFTA. *National Bureau of Economic Research Working Paper Series* No. 16535.

Melitz, M. J., and D. Trefler. 2012. Gains from Trade when Firms Matter. *The Journal of Economic Perspectives* 26 (2):91-118.

Morrison Paul, C. J., and D. S. Siegel. 2001. The Impacts of Technology, Trade and Outsourcing on Employment and Labor Composition. *Scandinavian Journal of Economics* 103 (2):241-264.

Rigby, D., and S. Breau. 2008. Impacts of Trade on Wage Inequality in Los Angeles: Analysis Using Matched Employer-Employee Data. *Annals of the Association of American Geographers* 98 (4):920-940.

Rodríguez-Pose, A. 2012. Trade and Regional Inequality. *Economic Geography* 88 (2):109-136.

Rodríguez-Pose, A., and N. Gill. 2006. How does trade affect regional disparities? *World Development* 34 (7):1201-1222.

Rojas-Romagosa, H. 2010. *Wage inequality in trade-in-tasks models*: CPB Netherlands Bureau for Economic Policy Analysis.

Sachs, J. D., and H. J. Shatz. 1994. Trade and Jobs in U.S. Manufacturing. In *Brookings Papers on Economic Activity*, eds. A. Deardorff and R. E. Hall, 1-84: The Brookings Institution.

Sánchez-Reaza, J., and A. Rodríguez-Pose. 2002. The Impact of Trade Liberalization on Regional Disparities in Mexico. *Growth and Change* 33 (1):72-90.

Silva, J. A., and R. M. Leichenko. 2004. Regional income inequality and international trade. *Economic Geography* 80 (3):261-286.

Sjöberg, Ö., and F. Sjöholm. 2004. Trade Liberalization and the Geography of Production: Agglomeration, Concentration, and Dispersal in Indonesia's Manufacturing Industry. *Economic Geography* 80 (3):287-310.

Slaughter, M. J. 2000. What Are the Results of Product-Price Studies? In *The Impact of International Trade on Wages*, ed. R. C. Feenstra, 129-170. Chicago: University of Chicago Press.

Stolper, W., and P. A. Samuelson. 1941. Protection and Real Wages. *Review of Economics and Statistics* 9:58-73.

Topalova, P. 2010. Factor Immobility and Regional Impacts of Trade Liberalization: Evidence on Poverty from India. *American Economic Journal: Applied Economics* 2 (4):1-41.

Venables, A. J., and N. Limão. 2002. Geographical disadvantage: a Heckscher-Ohlin-von Thünen model of international specialisation. *Journal of International Economics* 58 (2):239-263.

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

Wallerstein, I. 1979. *The Capitalist World-Economy*. Cambridge: Cambridge University Press.

Wood, A. 1994. *North-South trade, employment, and inequality: Changing fortunes in a skill-driven world*. Oxford England/New York: Clarendon Press/Oxford University Press.

———. 1995. How Trade Hurt Unskilled Workers. *The Journal of Economic Perspectives* 9 (3):57-80.

Chapter 3

Empirical Evidence of the Connection between Trade and Wage Inequality

3.1 Introduction

The aim of this chapter is to examine the connection between trade and wage inequality in the U.S. during the period 1990-2007. This examination is empirical in nature and takes the form of regression models with wage inequality, defined as wages for groups of workers with low- and high-education, as the dependent variable. The independent variables in the regression models capture characteristics of workers and characteristics of the establishments in which they work. The key independent variable is a measure of import competition from low-wage countries (LWCs). I find that import competition from LWCs is significantly related to increased inequality, driving down wages for U.S. manufacturing workers with low levels of formal education and driving up wages for U.S. manufacturing workers with high levels of education. Further, results indicate that import competition increases the nonproduction worker share of total wages within establishments, another measure of wage inequality related to differences in worker skills/education. This chapter also reveals that the relationship between wage inequality and low-wage import competition varies substantially across U.S. regions.

The empirical work in this chapter updates and addresses several limitations of previous studies on the relationship between trade and inequality. That literature, discussed in the previous chapter, focused largely on the 1980s, a period of rapid increases in wage inequality across many developed economies. For the most part, these early studies concluded that trade played a relatively minor role in the growth of wage inequality, the primary cause of the growing wage gap being linked to skill-biased technological change (e.g., (Haskel and Slaughter 2002)). Recent research suggests that the time is right to re-examine the trade-wage inequality link (Baldwin 2006; Grossman and Rossi-Hansberg 2006; Krugman 2008). These claims reflect the increased integration of the global economy since the 1980s, particularly the role of offshoring as a competitive strategy, and they capture the concomitant rise of emerging economies, notably China, as exporters to much of the developed world. Standard trade theory, built around the arguments of comparative advantage, envisions trade between countries with quite different factor endowments as having the most significant impact on factor-price movements. Thus, the rapid growth of trade since the early-1990s between developed countries such as the United States and emerging low-wage wage countries might be expected to have a greater impact on wage inequality within countries than the East-West trade flows that dominated Krugman's models of monopolistic competition.

The empirical investigation discussed below benefits from the use of microdata. These data overcome a number of weaknesses that hampered the modeling efforts of the 1990s. First, the microdata allow the separation of U.S. trade flows (imports and exports) with low-wage countries from U.S. trade flows with medium- and high-wage countries. Second, the microdata allow workers to be linked to establishments. Worker wages are a function of both individual worker characteristics and the characteristics of the establishments and firms for which they work. Much of the prior work on the relationship between import competition and wage inequality was conducted at the industry level and thus the influence of individual worker and business characteristics could not be controlled. In the cross-sectional analysis below, separating models by educational achievement overcomes use of general proxies for levels of worker-skill/education, while offering greater insight into the impact of trade on the wages of workers with different opportunities in the labor market. In the panel models below, controls for unobserved heterogeneity at the establishment level remove a significant complication of earlier analysis. Third, the microdata also make it possible to estimate models of trade and wage-inequality for different regions within the United States, thus exploring whether there is significant spatial variation in trade-inequality links across the U.S.

The remainder of this chapter is structured in the following manner. Section 2 describes the data used in the analysis, including the sources for the measure of import competition used in all the models, the employer-employee linked cross sectional data, and the establishment panels. Section 3 discusses the models used and their origins in prior theoretical and empirical work. Section 4 presents the results. A short conclusion ends the chapter.

3.2 Data

3.2.1 The U.S. Census Bureau Confidential Microdata Sets

The data used in this study are confidential microdata accessible to qualified researchers with approved projects for statistical purposes in the Research Data Centers (RDCs) of the U.S. Census Bureau's Center for Economic Studies. While public use microdata are increasingly available at the person-level and some synthetic establishment-level data are available (Kinney et al. 2011), the public data are limited in the level of geographical detail available, which helps maintain the confidentiality of survey and census respondents. The non-public RDC versions of the data include person- and establishment-level data with geographical information down to at least Census tracts. This study combines several non-public RDC datasets to create a sample of individual employees linked to their employers and to create panels of establishments with regional information attached. The Decennial Census and American Community Survey (ACS) are combined with the Census of Manufactures (CMF) to construct the matched employer-employee cross-sections. The panels of establishments are constructed from the Census of Manufactures. Both the cross-sections and the panels use a measure of import competition built largely from the Import and Export Series, transaction-level trade data from the Foreign Trade Division of the U.S. Census Bureau. The combination of these non-public microdata sources provides powerful analytical data sets used to test the empirical models of trade and wage inequality. Section 2.2 describes the construction of the measure of import competition from low-wage countries. Section 2.3 details the matching process that links workers and establishments. Construction of the panel of manufacturing establishments is described in the last subsection, 2.4.

3.2.2 Import Competition Measure

The measure of low-wage country import competition used in this paper (*LWICOMP*) is the ratio of low-wage imports within industry *i* in year *t* to the value of output in industry *i* and year *t* that is available for domestic consumption. This has become a standard measure of import competition used in the literature (see (Bernard, Jensen, and Schott 2006):

$$LWICOMP_{it} = \frac{IMPORTS_{it}^{LWC}}{IMPORTS_{it} + SHIPMENTS_{it} - EXPORTS_{it}} \tag{1}$$

where $IMPORTS_{it}^{LWC}$ is the value of imports coming into the U.S. in industry *i* at time *t* for low-wage countries and $IMPORTS_{it}$ is the value of imports from all countries; $SHIPMENTS_{it}$ is the total U.S. domestic production (shipments) and $EXPORTS_{it}$ represents U.S. exports. Imports and exports, by industry and year, are derived from the individual level transactions that comprise the published import and export series produced by the Foreign Trade Division of the U.S. Census Bureau. Shipments are from the CMF, aggregated from the establishment level to industry-year measures.[9]

Low-wage countries are defined by the World Bank country classification scheme that assigns countries into four income groups every year: low income, lower middle income, upper middle income, and high income. I use the World Bank countries classified in the low-income group for 1992 as the low-wage group of countries throughout my period of analysis. That year, 1992, is the earliest year of trade data available in the RDCs and also captures more consistent definitions for many countries included in the study (e.g., former Soviet countries). These countries had Gross National Income (GNI) per capita less than or equal to US$545 in 1992.[10] This set of 51 countries (notably including China) remains consistent in the LWICOMP calculations, even though some of the 51 countries might have moved out of the World Bank low income class by 2007 (see Table 1).

[9] To construct the imports and exports, I use a crosswalk developed by Pierce and Schott (2012) to translate the product level information (10-digit Harmonized System (HS) codes) into the manufacturing industries that produce those products. The Pierce and Schott crosswalk translates HS product codes to North American Industry Classification System (NAICS) industry codes. For the panels using only CMF data, I leave the LWICOMP measure at the state-NAICS industries-year level. For the cross-sectional, matched employer-employee data, I further aggregate the NAICS industries (over 450 codes in the manufacturing sector) into Census Bureau industry codes (roughly 72 codes in manufacturing), which are the industry codes assigned to people with work experience in the demographic Censuses and Surveys collected by the U.S. Census Bureau. CMF shipments data are similarly constructed and aggregated for the different analytical datasets.

[10] See the World Bank's Atlas methodology documentation for more details on how this was calculated: http://data.worldbank.org/indicator/NY.GNP.PCAP.CD.

3.2.3 Cross-sectional Linked Employer-Employee Data

To test the effect of import competition on workers' wages, I construct a matched employer-employee dataset, using demographic and establishment census and survey data. The Decennial Census (1990, 2000) and ACS (grouped year files for 2005-2007) contribute worker-level variables to this matched database including: educational attainment, age, sex, nativity binary distinguishing U.S.-born workers and foreign-born workers, a race and ethnicity binary variable distinguishing non-Hispanic whites from everyone else, and whether the work location is in a metropolitan area or not. From the Decennial and ACS, I also construct a variable capturing the percent of foreign-born workers with less than a high school education in each state and industry. This variable is a proxy for the influence of low-wage immigration on wages.

In the matched employer-employee data the Census of Manufactures (CMF) contributes establishment-specific characteristics including total value of shipments as a measure of establishment size, the ratio of capital to labor as a measure of the capital intensity of the business, the value of exports from that establishment, and a measure of the computer share of new investment that is widely used as an indicator for skill-biased technological change.

I construct the employer-employee matched data by making a probabilistic match between workers (in the Decennial and ACS) and plants (in the CMF) based on industry code and small area geography.[11] A unique match is found when a worker is employed within an

[11] The geographical unit used was based off Census Tracts – place of work tract for workers and location of the plant for manufacturing establishments. Because the data span the changes in Census Tract geography from 1990 to 2000 and because the geographical definitions in the demographic and establishment data were often based on differing years, consistent geography across the entire timeframe was developed. Tracts with no boundary changes from 1990 to 2000 were straight forward to deal with. For tracts with boundary changes, groups of tracts were constructed so that the areas used in matching were consistent over time.

industry and a census tract for which there is only a single establishment. For workers with non-unique matches to plants, where there are two or more plants in the same tract and the same industry, I calculate a weighted average of the plant characteristics for that industry-census tract combination. With the non-unique matches I lose some variability in the plant data (smoothing out variation into averaged characteristics), but I am able to keep many more of the individual worker observations than if I relied on unique matches alone. Beyond increasing the sample size, this decision also allows for the inclusion of many more workers in cities and dense manufacturing areas. Many of the individuals in the averaged match set are located in denser areas, hence the higher the proportion of people working in metropolitan areas in the averaged set. This, as expected, is accompanied by slightly higher average wages and education levels, as well as higher values for variables related to immigrant density. Otherwise broadly similar, these differences between the workers in the averaged and unique match sets can be seen in Table 2 in the descriptive results section below.

This matching process yields a sample which I limit to full-time, full-year workers. I define full-time, full-year workers as those who worked at least 35 hours in the week prior to that surveyed and at least 45 weeks in the previous year. When I limit the sample in this way, the remaining individuals work an average of 44 hours per week and 52 weeks per year. If we assume that part-time workers are more vulnerable to wage reductions or cuts to the number of hours worked and have less job stability, limiting the sample to workers who appear to be full time employees, should bias the sample towards a group of workers less vulnerable to import competition. This also aids in interpreting the reported wages and salary as actual annual earnings.

3.2.4 Establishment Panels

One of the limitations of the cross-sectional data is that it cannot account for unobserved heterogeneity among workers or establishments and it gives only limited information about dynamics, since the individuals and establishments included in each year's cross-sectional sample vary. Unfortunately forming a panel of individuals matched to plants is not possible with these data due to restrictions (technical and policy) on longitudinal linking of the Decennial Census and American Community Survey. However, it is possible to build a longitudinal panel of establishments using the Census of Manufactures, foregoing the demographic detail, but controlling for unobserved heterogeneity among establishments.

The establishment panel is unbalanced, including manufacturing plants that are found in at least two consecutive Economic Censuses from the years 1992, 1997, 2002, and 2007. The dependent variable is the change in the share of total payroll paid to nonproduction workers that serves as a proxy measurement for wage inequality.[12] The prediction is that the nonproduction wage share should increase as LWC imports lessen demand for low-skill workers in U.S. manufacturing plants. The panel includes a slightly different set of control variables, specific to each establishment: capital/value-added rather than capital/labor ratio, a single-unit or multi-unit firm indicator, establishment age. Shipments, exports, and computer share of investment are defined as they were in the cross-sectional matched employer-employee models. The computer share of investment information was not collected in the 1997 CMF, so for that year I impute the

[12] This measure is based on the idea that nonproduction workers are likely mostly managers, designers, etc., a high-skill group of workers, so that the nonproduction/production wage ratio ought to capture a wage differential across broad skill levels. This is a somewhat problematic assumption, potentially lumping janitors or cafeteria workers in with managers in the nonproduction category, blurring assumed skill, education, and wage categories. However, it is the only possibility for assessing the affects on wage inequality at the establishment level with CMF data.

value from the surrounding years.[13] Another additional variable gathered at the firm rather than the establishment level is a dummy indicating whether the firm reports related-party trade with low-wage countries, here used as a measure of direct engagement in outsourcing to low-wage countries. Finally, the main variable of interest is again low-wage import competition (LWICOMP), which is defined in the same way as in the matched cross-sectional data, but using finer industry categories: as many as 472 six-digit NAICS industries, rather than the 72 Census manufacturing industries.

3.3 Models

The aim of this paper is to measure the extent to which low-wage import competition is related to wage inequality among U.S. manufacturing workers. I take two separate approaches to accomplish this. The first approach exploits the matched employer-employee data, to examine separately the wages of low-education workers and high-education workers and relate this to industry-specific low-wage import competition. The second approach exploits the panel of establishments, examining changes in the nonproduction worker wage share and relating this to import competition. The statistical models that underpin each of these approaches are related, though distinct. At root, these models borrow a relatively standard wage equation, after Mincer (1974), and augment that equation with establishment and firm characteristics, reflecting newer literature on firm heterogeneity and growing recognition that establishment and firm characteristics impact productivity and wages (e.g., Troske 1999). The focus on trade leads me to

[13] Pooled OLS models of nonproduction wage share, using these establishments, show similar patterns with and without the 1997 establishments included, suggesting that this imputation is not driving spurious results.

add a variable measuring industry specific import competition from low-wage countries and a measure of skill-biased technological change. From (Feenstra and Hanson 1999) through to Ebenstein et al. (2013), the form of these wage models has been relatively consistent.

I hypothesize that low-wage import competition will affect wages through two mechanisms. One is a demand effect, lowering demand for low-skill workers who perform jobs done more cheaply in low-wage countries. This should also increase demand for high-skill workers as firms shift their product mix towards products that high-wage workers have a comparative advantage in manufacturing. The other mechanism is a productivity effect. As firms in the U.S. adjust their product mix in the face of import competition, they should also become more productive. With this increased productivity should come higher wages for all workers in the firm (or at least all workers that keep their jobs). Thus, I hypothesize that low-wage import competition should decrease the wages of less-educated workers, and increase the wages of workers with higher levels of education via the relative labor demand shifts. Simultaneously, I expect the wages of all workers remaining employed to rise from the increased productivity of firms driven by import competition. I am agnostic on which will be a larger effect for low-education workers, the productivity or demand shift. However, increased inequality between the wages of high- and low-education workers should increase regardless of the relative size of the two impacts on low-education workers. Skill-biased technological change is expected to increase wages, perhaps having a larger impact on the wages of highly-educated workers rather than less-educated workers. In similar fashion, I hypothesize that LWC import competition and skill-biased technological change should increase the nonproduction wage share.

3.3.1 Cross-sectional Matched Employer-Employee Model

The basic model for the employer-employee approach relates individual reported annual wages to low-wage import competition and several control variables:

$$W = f(PERSON, ESTAB, MIGRATION, SBTC, LWICOMP) \qquad (2)$$

where *W* represents the annual wages of a worker, *PERSON* represents the worker's demographic characteristics, *ESTAB* represents the plant characteristics where the worker is employed, *MIGRATION* represents the regional migration context, *SBTC* represents skill-biased technological change, and *LWICOMP* represents import competition from low-wage countries. I estimate this equation separately for groups of workers with different levels of formal educational attainment. There is a strong correlation between formal education and wages in the U.S., so observing how import competition affects workers with high and low levels of formal education should give a good indication of its overall effect on wage inequality among manufacturing workers.

The econometric specification I use is

$$W_{jt} = \alpha + \boldsymbol{\beta}'_u \boldsymbol{P}_{ujgt} + \boldsymbol{\beta}'_v \boldsymbol{E}_{vkt} + \beta_1 M_{jits} + \beta_2 SBTC_{kt} + \beta_3 LWICOMP_{it} + \delta_t + \delta_i + \delta_s + \varepsilon_{jit} \qquad (3)$$

where W_{jt} represents the annual wages of worker *j* at time *t*; $\boldsymbol{P}_{ujgt}$ is a *u*-element vector of worker characteristics for worker *j* with education level *g*, including age, sex, nativity, and race-ethnicity; E_{vkt} includes a *v*-element vector of features of establishment *k*, including establishment size, capital-labor ratio, and value of exports; M_{jits} is a measure of the prevalence of low-education immigrant workers in the industry and state of the worker; $SBTC_{kt}$ is an establishment-specific measure of the share of investments made by that establishments in computers, capturing skill-biased technological change arguments; $LWICOMP_{it}$ is the measure of import competition from low-wage countries, specific to each industry and year. This specification also includes three fixed effects terms: δ_t is a year dummy that accounts for business cycle dynamics; δ_i is an industry fixed effect that captures sector-specific wage shocks unrelated to trade; δ_s absorbs state-specific shocks. Finally, ε is an error term that satisfies classical regression assumptions.

To gain insight into the subnational dynamics of the relationship between wages and import competition, I estimate equation (3) for each of the nine Census regions of the United States. For the regional models, I also run the models for each year, to capture some sense of how this relationship might be shifting over time. Further, I run the model on finer-grained education groups: workers with less than a high school diploma, those with a GED or high school diploma, those with some college education, and those with at least an Associate's degree or a BA.

The main variable of interest in this model (whether estimated at the national or regional level) is low-wage import competition, measured by LWICOMP. In equation (3), if the coefficient β_5 is greater than zero, then higher levels of low-wage import competition raise the average wages for the workers included in that specification. If β_5 is less than zero, then the higher low-wage import competition lowers average wages for that group of workers. For workers with low levels of formal education, I expect the coefficient for LWICOMP to be negative, indicating lower wages in relation to higher import competition. For workers with high levels of education, I expect to see the reverse. Together these would suggest increased wage inequality in the presence of increased low-wage import competition.

Beyond the low-wage import competition measure, the computer share of investment is also of particular interest. The conclusion of many of the 1990s studies on trade and technical change was that skill-biased technological change was far more important than trade in driving wage inequality. The computer share of investment measure should capture skill-biased technology investments, and I expect this to have a negative relationship with the wages of low-education workers and a positive relationship with high-education workers.

3.3.2 Establishment Panel Model

Empirical analysis of the relationship between trade and wage inequality using the panel of establishments is based on a relatively standard model specification (Ebenstein et al. 2013; Feenstra and Hanson 1996; Kemeny and Rigby 2012; Kemeny, Rigby, and Cooke 2013). This approach exploits the temporal variation in establishments and trade patterns. It relates change in the nonproduction share of total payroll to the change in low-wage import competition and several control variables:

$$y = f(SHIPMENTS, CAPITAL\ INTENSITY, SBTC, LWICOMP) \quad (4)$$

where *y* represents the ratio of the average wages of nonproduction to production workers; *SHIPMENTS* represents the total value of shipments of an establishment; *CAPITAL INTENSITY* measures the relative capital intensity of an establishment; *SBTC* represents skill-biased technological change; and *LWICOMP* represents trade, and specifically, import competition from low-wage countries.

To examine these relationships, I use the following econometric specification:

$$y_{kt} = a + \beta'_u E_{ukt} + \beta_1 SBTC_{kt} + \beta_2 LWICOMP_{it} + \delta_t + \delta_i + \delta_s + \varepsilon_{it} \quad (5)$$

where y_{kt} is the ratio of average wages of nonproduction to production workers in establishment k in year *t*; E_{kt} includes a *u*-element vector of features of establishment *k*, establishment size, capital/value-added ratio, whether the establishment is part of a multi-unit firm, and value of exports; $SBTC_{kt}$ is an establishment-specific measure of the share of investments made by that establishments in computers, capturing skill-biased technological change arguments; $LWICOMP_{it}$ is the measure of import competition from low-wage countries, specific to each industry and year. This specification also includes three fixed effects terms: δ_t is a year dummy that accounts for business cycle dynamics or, more generally, time-specific shocks to the wage ratio; δ_i is an industry fixed effect that captures sector-specific wage shocks unrelated to trade; δ_s absorbs state-specific shocks. Finally, ε is an error term assumed to satisfy classical regression assumptions.

The data allow for results at both the national and census regional division level. These models are fitted using a fixed effects panel approach that accounts for any time-invariant unobserved heterogeneity among establishments. An extension to this specification is the inclusion of industry- and year-specific EU imports from low-wage countries as an instrument for LWICOMP. This instrument is described in more detail in section 3.4.2., below.

Again, the variable of interest in this model is low-wage import competition (LWICOMP). In this model, if the coefficient β_4 is positive then higher levels of import competition raise the share of nonproduction worker wages, indicating an increase in inequality.

3.4 Results and Discussion

3.4.1 Description of the Analytical Samples

One advantage of the Census Bureau microdata not yet mentioned is that the raw data sets are huge. Even shedding many observations in the matching process for the employer-employee data or limiting the establishments in the panel data to incumbent plants that are present in at least two Economic Censuses, the sample sizes in the resulting analytical data sets are very large. In the matched employer-employee data, there are hundreds of thousands of workers. Across the three years, the low-education manufacturing workers, defined here as workers having a high school diploma or less education, include 995,000 workers.[14] The high-education manufacturing workers, defined as workers with an Associates degree, a Bachelors degree, or higher degrees, include 479,000 individuals. The region-year-education group subsamples range from about 2000 workers to 112,000 workers. In the panel models of individual establishments, there are just over 600,00 observations in the national sample, spanning the four years 1992, 1997, 2002 and 2007, and tens of thousands of establishments in each regional subsample.

[14] The sample sizes throughout this study have been rounded to the nearest 1,000 to facilitate the disclosure avoidance review process through the U.S. Census Bureau's Center for Economic Studies.

3.4.2 Empirical Results for the National Matched Employer-Employee Cross-sectional Models

Table 2 presents descriptive statistics for all manufacturing workers identified in the Decennial Censuses of 1990 and 2000 along with workers in the ACS for 2005-2007. The table also provides descriptive statistics for the set of workers matched to establishments (unique and average). T-tests reveal that the differences between the employer-employee matched samples and the broader population are statistically significant, even though in most cases those differences are relatively small. The significance largely reflects the large sample sizes. The largest differences are found in establishment characteristics between the matched plants and all plants in the Census of Manufactures (CMF) (lower panel). The matched samples are biased towards establishments with much larger output, as the average total value of shipments (TVS) is over ten times larger in the matched samples than in the underlying population of plants. Table 2 thus raises questions regarding a large-firm bias in the sample of matched plants examined. Theoretically, larger plants are more likely to be exporters and more likely to be engaged in offshoring. With offshoring increasingly linked to more routine, less-skilled jobs, the focus on such plants might over-emphasize the impacts of import competition on wage inequality. This should be taken into account as we examine the results below.

Using the cross-sectional data with workers matched to employers described above, and pooled across the three time-periods analyzed, I produce ordinary least squares (OLS) and two-stage least-squares (2SLS) regression estimates of equation (3). The results of each of these types of estimates for low- and high-education workers are shown in Table 3. These models all incorporate state, industry, and year fixed effects.

The first column reports the OLS estimates for low-education workers, those with no more formal education than a high school diploma. The demographic characteristics appear to be operating in a manner consistent with expectations. Being a male, older, native-born, and non-Hispanic white are all significantly associated with higher wages. Working in a metropolitan area (rather than the suburbs or rural areas) is also positively and significantly associated with higher wages. The migration context variable also works as expected: working in an industry and a state where a higher percentage of the industry- and state specific workforce comprises foreign-born workers with less than a high school degree, is significantly associated with lower wages. The establishment-specific variables also operate much as we might expect. Larger establishments, more capital-intensive establishments, and plants that export pay significantly higher wages on average. It is notable that both the demographic characteristics and the establishment-level characteristics operate as theory suggests in this matched employee-employer data.

Column 1 of Table 3 also reports how the average wages of less educated workers are related to skill-biased technological change and to low-wage import competition. The results show that higher shares of computer investment are associated with significantly lower average wages for less-skilled workers. This result is a bit surprising. I anticipate higher shares of computer investment raising the average wages of highly educated workers, but why it might reduce the wages of less-educated workers is not central to the SBTC theory. What this may be capturing to some extent is computer investments substituting for low-skill labor, decreasing demand, and therefore wages for those workers. Consistent with my theoretical priors, increases in low-wage import competition exert a significant negative impact on the average wages of less-educated workers.

The second column shows the same OLS model but for workers with high levels of formal education, those with an associates degree, a BA, or more. Again, being male, being older, and being non-Hispanic white are all positively and significantly related to higher wages.

Nativity is negatively related to wages for these workers, but the coefficient is not significant. Working in a metro area remains positively and significantly related to wages. Interestingly, the prevalence of foreign born, low-education workers in workers' state and industry is also significantly associated with lower wages. It is possible that this means that the high-education workers employed in industries with many low-education, foreign-born colleagues, are working in industries with lower wages in general. The establishment level variables (total value of shipments, capital-labor ratio, and exports) are all positively and significantly related to wages. The share of computer investments is positively related to wages, but is not significant. Once more this is a surprising finding. It may be that the computer share of investment measure used in these models is capturing wage effects that are slightly different from those predicted by standard SBTC mechanisms, as mentioned above. However, it might also be that the actual relationship between technology change and wages for these workers is different than it was during the time periods studied in previous research (e.g., (Haskel and Slaughter 2002)). Finally, low-wage import competition is positively and significantly related to wages for high-education workers, meaning higher LWICOMP is associated with higher wages of high-education workers.

Considering the results of these first two columns together gives insight into the inequality dynamics associated with imports from low-wage countries. Recall that for low-education workers, increased low-wage import competition is related to lower average wages. For high-education workers, the reverse is true, increased low-wage import competition is related to higher average wages. This suggests that higher import competition is associated with higher wage inequality across groups of manufacturing workers stratified by education. It is notable that this appears to be operating not only by suppressing the wages of workers with relatively low levels of education, who we might think of as being in direct competition with the workers in the low-wage exporting countries, but also by increasing the wages (through increased demand and/or productivity increases) of U.S. workers with higher levels of education.

The results discussed so far in the first two columns of Table 3 assume that import competition drives adjustment within U.S. manufacturing plants. However, it is possible that increased U.S. imports are themselves the result of prior decisions by U.S. manufacturers to engage in offshoring, substituting foreign production for domestic operations. This case raises the possibility of simultaneity bias in the regression models, generating one form of endogeneity. The conventional way to try and dampen concerns with endogeneity is to employ an exogenous instrumental variable that is reasonably well-correlated with the endogenous independent variable, in this case, the measure of low-wage import competition and that is exogenous to the error term. The instrumental variable I employ is a measure of low-wage imports for the EU15 countries of Europe, from the same low-wage countries used in the U.S. import competition measure. This measure of European imports is constructed for the same industry groups and time period that frame the matched U.S. employer-employee data. It is reasonable to assume that this variable is not impacted by the competitive adjustments of U.S. producers and simple statistical tests show that this variable is reasonably well-correlated with low-wage import competition across U.S. manufacturing sectors.

Columns 3 and 4 of Table 3 report two-stage least-squares results of the impact of low-wage import competition on manufacturing wages, employing the instrumental variable in place of the original measure of U.S. import competition. Column 3 repeats the analysis for workers with low levels of education, while Column 4 provides results for the set of workers with high levels of education. In the models run for both low- and high-education workers, the first stage diagnostics reported at the bottom of the table indicate the suitability of the instrument. The Kleibergen-Paap (K-P) rk LM Chi-squared/p-value statistics indicate that the instrumented model passes this underidentification test. The Kleibergen-Paap (K-P) F-statistic reports on the instrument relevance, and with a value well above the Stock-Yogo critical values, I conclude that the instrument is relevant and not weak. Unfortunately with only one instrument, I cannot report statistics relevant to overidentification (e.g., Hanson's J).

The 2SLS model results (Columns 3 and 4) broadly resemble the original set of OLS results presented in Columns 1 and 2 of Table 3. For both groups of workers, individual person and average plant control variables in the 2SLS models exhibit the same signs and similar patterns of significance as in the OLS models. Notably, the computer share of investment coefficients and standard errors are remarkably similar in the 2SLS and OLS models. The main difference between the two specifications is that the coefficient on low-wage import competition in the 2SLS models is larger than in the OLS models, about 25% larger for less educated workers and almost 60% larger for more educated workers. It is difficult to assess which set of regression coefficients provides the best estimates of the influence of import competition in Table 3, for while the OLS results might be compromised, we also know that the use of instrumental variables generates some bias in estimated coefficients. In addition, the relatively large standard errors in the 2SLS models also suggests some loss of precision in estimation. Regardless, the significance of the regression coefficients on low-wage imports in Table 3 is consistent with theory.

As a further robustness test of the general model of low-wage import competition and wages by education, Table 4 presents the results of similar model specifications for low- and high-education workers using the set of employees matched to unique establishments. In this sample of workers, the characteristics of the establishments where each person works are always the reported characteristics, not averaged characteristics based on more than one plant. In general, the results in Table 4 look quite similar to those in Table 3. Across workers with lower and higher levels of education, individual person-level characteristics influence wages in line with theoretical expectations. The same is true for most plant characteristics, though exports do not significantly increase the wages of more educated workers. Focusing on the key variables of interest, Table 4 also reports that low-wage import competition exerts a significant negative impact on the wages of less-educated workers while it has a significant positive influence on the wages of workers with higher levels of education. Skill-biased technological change lowers the wages of less educated workers but has no impact on the wages of workers at the top end of the education distribution. These results are largely consistent with the estimates presented in Table 3, which used the data with the averaged establishment characteristics.

3.4.3 Empirical Results for the National Establishment Panel Models

A final set of results at the national level sheds further light on the relationship between import competition and wage inequality. One of the concerns that may be raised in terms of the cross-sectional analysis reported above is unobserved heterogeneity. To remedy this worry, I estimate a fixed-effects panel variant of equation (5) where observations are individual manufacturing establishments tracked across consecutive Economic Census years – 1992 to 1997, 1997 to 2002, and 2002 to 2007. Use of the panel models removes concerns with unobserved heterogeneity at the plant-level, but this comes at some cost since the panel model outlined in equation (5) contains no information on individual worker characteristics.

Lacking worker-level information in these panel models, the relationship between import competition and wages is captured through the separation of wages paid to production and nonproduction employees within the establishment. While an imperfect division in many respects, it has proved common in the literature to equate nonproduction workers as skilled or more educated and production workers as unskilled or less educated in relative terms. Tracking the nonproduction share of the establishment's total wage bill then provides a convenient way of assessing the relative fortunes of different types of workers.

Table 5 presents the results of estimating a fixed effects panel model of equation (5) at the national level for all manufacturing establishments that can be identified in at least two Census years. Two variants of the panel model are presented again, the first in Column 1 ignoring potential concerns with endogeneity and the second in Column 2 once more employing an instrumental variable approach to mitigate endogeneity issues. In this way the results of Table 5 can also be compared in a general way with those of Tables 3 and 4. Industry, state and year fixed effects are included in the model specifications generating the results of Table 5.

The OLS estimates of the nonproduction wage share are displayed in Table 5, Column 1. On the one hand, larger establishments and establishments that are part of a multi-plant firm have a negative and significant relationship to the nonproduction wage share. On the other hand, plant age, higher computer share of investment, direct outsourcing to low-wage countries, and low-wage import competition all have a positive and significant association with the nonproduction wage share. Following the literature, the increased nonproduction wage share is interpreted as an increase in wage inequality.

In Table 5, Column 2, which shows the second stage results employing the EU imports instrument, the coefficient for LWICOMP is positive and significant, indicating that increased import competition is associated with an increase in the nonproduction wage share. Recall that this increase is interpreted in the literature as an increase in wage inequality. This positive association is the same relationship observed in the OLS specification in Column 1, but it is much larger in the 2SLS estimation. Also contributing significantly to an increase in the nonproduction wage share are computer share of investment and having related-party imports from a low-wage country, and higher capital-value added ration (though the significance of this variable is only at the 10% level). These suggest that technology change and outsourcing to low-wage countries are also contributing to increasing inequality. Increased age of the establishment is now a mitigating factor against increased inequality. Along with plant age, being part of a multi-plant firm also decreases the nonproduction wage share, decreasing wage inequality. The first stage diagnostic statistics allow me to conclude that the EU imports instrument is neither underidentified nor weak.

This section has shown a variety of models indicating that increasing low-wage import competition is related to increased wage inequality in the U.S. Tables 3 and 4, using identical specifications but different samples of workers, show an increase in inequality between groups of workers with different levels of formal education. Using an alternate indicator of inequality, a slightly different specification, and a panel of establishments, Table 5 shows an increase in inequality within U.S. manufacturing establishments. Despite the different approaches and data, the findings are generally consistent. The effects from import competition appear to be operating at different scales and across different groups, but consistently increasing inequality when we examine the nation as a whole. In the next section, I examine whether these results are consistent across Census regional divisions.

3.4.4 Empirical Results for the Regional Matched Employer-Employee Cross-sectional Models

The previous section presented results for the U.S. as a whole, supporting the hypothesis that increased import competition from low-wage countries increases wage inequality among U.S. manufacturing workers. There is, however, substantial variation in imports, wage inequality, manufacturing intensity, and industry mix across the U.S. I expect that the national results, while robust, mask regional variation in the relationship between import competition and wage inequality.

This section presents results from estimating equation (3), which relates wages to low-wage import competition with a variety of control variables, but for samples divided into each of the nine Census regional divisions. In a slight departure from the national results, these models are estimated year-by-year and for four education groups. The education groups here are more detailed than in the national model. They include (a) workers with less than a high school diploma, (b) those with a GED/high school diploma, (c) those with some college education, and (d) those with at least an Associates degree or a BA. One hundred and eight models are estimated separately (9 regional divisions *x* 3 years *x* 4 education categories).

In the resulting regional models, the demographic, migration context, and establishment-specific control variables work much as we might expect from the national models. Thus, in this section, I present the results for the low-wage import competition (LWICOMP) coefficients in the different models.

In order to efficiently present all these models, Figure 1 shows a summary form of the results, mapping the sign and significance of the coefficient of low-wage import competition by divisions for 1990 and 2007. The maps on the top row show the trade effect on low-education workers. Low-education is defined here as having a high school diploma or less. The maps on the bottom row of the table display the trade effect on high-education workers, here defined as having some college or more.[15] The dark red represents a negative and significant coefficient (p-value maximum smaller than 10%) on LWICOMP, indicating that wages are significantly lower in that region for those workers in the presence of greater low-wage import competition. The light pink color indicates a negative coefficient, but one that is not significant even at the 10% level. The dark blue represents a positive and significant coefficient, indicating that wages are significantly higher in that region for that group of workers when import competition from low-wage countries increases. In this set of results, there are no regions with positive but insignificant coefficients on LWICOMP.

Focusing first on the top row of Figure 1, which presents the relationship between low-wage import competition and wages for workers with low levels of formal education, it is evident from the abundance of dark red shading that in many regions low-education workers have lower wages in the face of import competition. Three regions show important variation from 1990 to 2007. The Mountain states (Division 8) and the Middle Atlantic states (Division 2, including New York, New Jersey, and Pennsylvania) still appear to have a negative relationship between trade and wages by 2007, but the coefficient is no longer significant as it is in the 1990 map. However, the Pacific states (Division 9) shift in the other direction. In 1990, the relationship is negative but not significant. In 2007, the decrease in wages is significant. For many low-education workers across the U.S., the effect of import competition from emerging economies remains bleak throughout this time period, decreasing wages significantly.

[15] To condense the amount of data displayed, the four education categories are divided into just high and low groups. Significance in *at least one* of the categories (i.e., “less than high school diploma” or “GED/high school diploma”) is coded as significant in the map. More detail from the models is presented in Table 6.

Turning next to the bottom row of Figure 1, these maps display the relationship between LWICOMP and wages for workers with high levels of formal education and show a much different story than that experienced by the low-education workers. Across the country in 1990, many high-education workers were being hurt by low-wage import competition, with significantly lower wages (the dark red shading) everywhere except along the coasts. In the coastal regions, high-education workers were benefitting from low-wage import competition, earning significantly higher wages (dark blue shading). By 2007, in several regions, the relationship between LWICOMP and wages changed substantially. In the West South Central states (Division 7, including Texas), the relationship between trade and wages is still negative, but it is no longer significant. In the Mountain states (Division 8) and the West North Central (Division 4), wages for high-education workers are now higher with increased import competition, and this relationship is significant (dark blue shading). Only the East Central Region (Divisions 3 and 6) appear to have no one benefitting from the impacts of low-wage import competition. In those two divisions, the relationship between trade and wages is negative and significant.

The maps in Figure 1 reveal two interesting dimensions of inequality in the U.S. The first dimension is evident within a single point in time. Take the 1990 high-education workers as a clear example (lower left panel). Within this year, workers with similar levels of education see their wages diverging from their counterparts depending on what region they are working in. Highly educated workers in the middle of the country earned lower wages in the face of import competition from low-wage countries, but workers with similar levels of education on the coasts got a wage boost associated with the import competition. Thus there is a pattern driving inequality *across* regions. The second inequality dimension is clearest in the two 2007 maps, showing the trade effect on low-education workers (top right panel) and high-education workers (lower right panel). In several of the regional divisions there is a significant coefficient for low-wage import competition that is negative for low-education workers and positive for high-education workers (the Pacific states, Division 9, are an example of this pattern). Thus, in 2007, LWICOMP is driving the wages for low- and high-education workers in opposite directions, increasing inequality *within* regions. It is possible to see how the detail in these maps would add up to the robust national inequality results described in the previous sections. However, they also demonstrate that there is much more subtlety to the inequality dynamics at play across the country, both within and across regional divisions.

To build on our understanding of the inequality dimensions shown by the summary maps, more detail from the results is given in Table 6, which presents the sign and significance of the LWICOMP coefficient from each of the 108 models. There is substantial variation across different parts of the country in the relationship between wages and import competition. How import competition affects workers with different levels of formal education is different division to division.

Many divisions reflect the national story of negative impacts on wages for low-education workers and positive impacts on wages for high-education workers. Referring to Table 6, Part A, the South Atlantic states (Division 5) show this pattern most clearly and consistently over time, with a negative and significant relationship between wages and import competition for workers with a high school diploma or less and a positive and significant relationship for workers with a college degree or more in each year. Other states also largely follow this pattern, though with some variation on it year to year. These include New England (Division 1), and the Middle Atlantic (2), West South Central (7), Mountain (8), and Pacific (9) divisions. In each of these divisions, low-wage import competition appears to be generally driving wages apart for workers with low- and high-levels of education in most years.

However, in two other divisions, the pattern is different, with nearly all education groups negatively associated with import competition (as was evident in Figure 1). In the East North Central (Division 3) and East South Central (Division 6), import competition is significantly and negatively related to wages for workers in nearly all education groups over time, indicating that nearly all workers in these areas receive lower wages as import competition increases. The exceptions to this overwhelming pattern in both divisions (a positive sign for college educated workers in 1990 and a negative sign for the same workers in 2007) are not significant at even the 10% level.

There are also some notable trends within regional divisions across time. In some divisions, there is substantial change in the effects of import competition on wages for different education groups over the three years observed. For example, in the Mountain states (Division 8, see Table 6B), the relationship between import competition and wages appears to be improving over time across the educational spectrum. In 1990, for nearly all workers, except those who finished college, the association between import competition and wages was negative and significant. For the workers with a college degree the relationship is positive but not significant. By 2000, for workers with even some college, the relationship is positive and highly significant (at the 1% level), and only the wages of workers who do not have a high school diploma have a negative and significant relationship to import competition. In the latest year observed, 2007, for workers with the lowest levels of formal education, the relationship is negative, but no longer significant at even the 10% level. Overall in the Mountain division, the relationship between low-wage import competition and wages appears to be improving welfare (by this one, narrow measure) for workers over time, or at least affecting most working in manufacturing less negatively.

Elsewhere, the changes over time appear less benevolent. For the Pacific states (Division 9, see Table 6B), the pattern appears to move from one where many workers were benefitting from import competition and few were being hurt by it, to one where wage inequality is worsening, with some workers benefitting but others experiencing significantly lower wages. In this regional division in 1990, import competition was positively related to wages for three of the education groups, though significantly for only those with at least some college. For workers with less than a high school diploma, the relationship is negative but not significant. By 2000, the sign has changed from positive to negative for those with a high school diploma, though the coefficient is still not significant. By 2007, the workers with the highest levels of education, those with at least some college, still appear to be benefitting, earning higher wages with increased import competition. However, by that time, workers with less than a high school diploma now earn lower wages (with significance at the 1% level) in the face of import competition. Overall in the Pacific division, there appears to be a clear pattern of increasing inequality over time.

The regional results suggest a less unified story than the national results. Again, the multiple dimensions of inequality are evident in Table 6. Some of the inequality dynamics operate across these relatively large regions, with nearly all workers in regions such as the East Central regions (North and South) being hurt by import competition, and at least many of the workers in regions such as the Mountain West being helped by these same types of imports. But some of the inequality is operating within these regions as well. Within the Pacific and South Atlantic divisions in particular, the import competition effect is evident, driving inequality between high- and low-education workers within each region. Thus, the regional models enrich the national models by giving a sense of how the national inequality pattern emerges, deepens, and is varied across the U.S. over time.

Next I turn to how establishment-level inequality varies across Census divisions.

3.4.5 Empirical Results for the Regional Establishment Panel Models

Returning to the panel of continuing establishments, I re-estimate equation (5) for the each of the nine Census regional divisions. This equation relates the change in the nonproduction wage share within establishments to the change in the low-wage import competition between Economic Census years. This is accomplished with a least-squares fixed effects estimator, which helps account for time-invariant establishment unobserved heterogeneity. EU imports from low-wage countries are included as an instrument for LWICOMP in these estimations. Since the dependent variable is the nonproduction wage share, positive coefficients on the independent variables imply that unit increases in those variables raise the share of total wages in an establishment paid to nonproduction employees. Following the literature, an increase in the nonproduction wage share is interpreted as an increase in wage inequality. Table 7, Panels A and B, presents the results for the each of the nine Census regional divisions.

Across the estimations for each regional division, the coefficients on several covariates vary in their sign and significance, presenting a mixed picture of the effect of those variables on the nonproduction wage share from place to place. For example, total value of shipments is significant in only three of the divisions, but the relationship is negative in two of those divisions (Division 4 and 9) and positive in the other (Division 7). The capital intensity of the establishments, measured here using the capital/value-added ratio, is significant in only two divisions; the relationship is negative in Division 2 and positive in Division 5.

Other covariates have significant relationships in only a few of the divisions, but where they are significant, the direction of association is consistent across regional divisions. The value of exports an establishment ships is positive and significant in two divisions (Divisions 1 and 9), increasing the share of payroll paid to nonproduction workers (increasing inequality). The age of the establishment is negative and significant in only one division (Division 7). And being part of a multi-establishment firm carries a negative and significant relationship to the nonproduction wage share in three divisions (Divisions 3, 4 and 9), decreasing the share of payroll paid to nonproduction workers (decreasing inequality). The measure of direct outsourcing, whether a firm engages in related-party trade in a low-wage country, has a positive and significant relationship in Divisions 6, 7, and 9 (increasing inequality).

In the context of this study, the two variables of most interest in these models are the computer share of investment and the measure of low-wage import competition. For each division, computer share of investment is positively and significantly related to the nonproduction wage share. When computers comprise a larger share of establishment investments in new machinery, nonproduction workers earn a larger share of the total payroll, suggesting an increase in wage inequality within the establishment. LWICOMP is also positively associated with the nonproduction wage share in all divisions, but in New England (Division 1) and East South Central (Division 6) the relationship is not significant at the 10% level. In the other divisions the measure of inequality (nonproduction wage share) is positively and significantly related to import competition. Recall that these other states displayed a pattern of lower wages for low-education workers and higher wages for high-education workers with increased import competition in the previous regional models.

The estimates in Table 7, Panels A and B include the EU low-wage imports instrument. In all divisions except Divisions 1 and 6, the instrument passes tests of underidentification (K-P rk LM Chi-squared/p-value) and weak identification (K-P F-statistic). In Divisions 1 and 6, the instrument appears to not be particularly useful. It is possible the weakness of the instrument explains why the association between LWICOMP and nonproduction wage share is not significant in these two divisions. Alternatively it is possible that the estimates for these two divisions are picking up something about the relationship between trade and wages in these specific places. Recall from the previous section (results of Table 6) that Division 1 showed a pattern of import competition associated with increased inequality, with low-education workers earning less and high-education workers earning more when import competition was higher, though the pattern was not consistent for each year. Recall also that nearly all Division 6 workers earned less when import competition was greater. If these results are suggestive of why the coefficient in the panel models is not significant for these two regions (Table 7, Panels A and B), it is perhaps surprising that East North Central (Division 3, Column 3) is significant at the 1% level, since it displayed a similar pattern to Division 6 in Table 6.

Together, the cross-sectional models and the panel models show that there is a more varied relationship between import competition and wage inequality when we zoom in below the national level. However, they also show that inequality between groups of workers is at least somewhat context sensitive, varying region to region.

3.5 Conclusion

The shape of international trade flows has fundamentally shifted over the past few decades, with exports from low-wage countries, such as China, storming onto the world market. This has substantially changed import flows into the U.S., shifting the competitive environment that U.S. manufacturers face. In most sectors, import competition from low-wage countries has increased relative to import competition from high-wage countries. The growing importance of imports from low-wage countries has prompted calls (e.g., Baldwin 2006; Grossman and Rossi-Hansberg 2006; Krugman 2008) to reexamine a consensus opinion on the relationship between trade and wage inequality that was formed out of a series of studies published largely in the 1990s (e.g., Berman, Bound, and Griliches 1994; Lawrence and Slaughter 1993), and which concluded that any role for trade in rising wage inequality in high-wage countries was minimal. The present chapter responds to this call for new empirical work on the trade and inequality relationship. The chapter employs an updated factor proportions theoretical framework and uses matched employer-employee microdata and establishment panels covering the period 1990-2007, when imports from low-wage countries were growing rapidly. The goal of the present study is to consider the impact of industry-specific low-wage import competition on the wages of manufacturing workers in different skill groups. Specifically, I examine the impact on the wages paid to workers with different levels of formal education and to nonproduction workers relative to production workers. While focusing on the relationship between wages and import competition, I also control for individual and establishment characteristics that affect wages. Importantly, I control for establishment-specific computer investments, a measure that captures skill-biased technological change (SBTC), often seen as the main alternate explanation favored by the studies that informed the earlier consensus rejecting a major role for trade in increasing inequality (see especially, Haskel and Slaughter 2002).

The primary finding is that low-wage import competition does significantly affect wages, and does so differently for workers with different skills. Controlling for individual demographic characteristics, contextual variables, and establishment characteristics, higher import competition lowers the wages of low-education workers and raises wages of high-education workers nationally. Low-wage import competition also increases the nonproduction worker share of total payroll, which is interpreted as an increase in inequality in the literature.

These findings strongly support the theoretical predictions that imports from low-wage countries should increase wage inequality in developed countries like the U.S. They also strongly support the idea that the old consensus on trade and wages cannot be applied to the most recent decades, especially since 1990 when imports from low-wage countries have increased sharply. The findings are compatible with recent empirical studies (e.g., Autor, Dorn, and Hanson 2012), that use different data and specifications. Perhaps there is a new consensus building on trade and inequality.

The findings also have implications for our understanding of the impact of technological change on wages that was the preferred explanation of much of the earlier work on explaining rising inequality. In many of the models presented, there is support for the idea that technological change as measured by computer investments is skill-biased. In the establishment panels, computer investments raise the nonproduction wage share. In the individual worker wage models, increases in the computer share of investment significantly lowers the wages of workers with low levels of educations. However, for high-education workers, the effect of computer share of investment is positive but not significant. This is notable because the high-education workers are exactly the group of workers we would expect to see benefitting from computer investments, according to the SBTC argument. These results present a significant departure from earlier work on the relative importance of trade and technology change for wages, and again suggest that the findings of the earlier studies cannot be generalized forward into and beyond the 1990s.

Underlying the national story, there is substantial subnational variation in the relationship between import competition and wages. While many areas of the country follow the national story with varying degrees of consistency over time, in two regional divisions, the positive relationship for the highest education workers is reversed, with nearly all workers at all levels of education displaying a negative relationship between wages and import competition. One important takeaway is that although we nearly always think about trade as a national-level phenomenon, the trade transactions that build the national flows come from and go to particular establishments embedded in particular regional economies. Consequently the effects of this trade are not evenly distributed across the country. This should be unsurprising to geographers, but many studies of trade still do not reflect this subnational dimension.

The variation in the regional results – both for inequality between groups of workers and inequality within establishments – suggest another insight. Trade effects are not acting on workers at a purely individual level, something we can ironically only see with access to microdata on individuals' wages with which we can control for personal characteristics. These individuals are working in plants, in firms, in industries, in regions – all of which shape the trade-wage relationship. This is compatible with recent work by Frías, Kaplan and Verhoogan (2009) where they find that individual skills mattered less than the contextual factors that drove wage premiums. It also appears to be consistent with Chiquiar (2008), who finds that the effects of trade vary based on regional engagement with the international market. His work shows that low skill workers in the northern Mexican states bordering the U.S. experienced the changes wrought by NAFTA very differently than the low skill workers in the southern Mexican states where the regional economy was more oriented towards the domestic economy. The results in the present study remind us that the regional context of trade and labor markets shapes the lived outcomes among workers.

The findings in this chapter may not reflect the full extent of the effect of trade on wages, particularly for those workers with lower levels of education. First, the sample only includes full-time, full-year workers, who presumably have greater wage protections and bargaining leverage than part-time workers. Further, the sample only reflects workers with full-time jobs within a dramatically shrinking manufacturing sector. Other work has recently shown that the measure of import competition used in this chapter also contributes significantly to manufacturing workers with lower levels of education losing a job and finding one with a lower salary, in any industry (Kemeny, Rigby, and Cooke 2013). Furthermore, Ebenstein et al. (2013), find that workers who leave the manufacturing sector suffer large, negative wage effects from offshoring, and Autor, Dorn, and Hanson (2012) find that import competition has a host of other negative labor market effects including increasing unemployment, decreasing labor-force participation, and increasing use of disability and other government benefits (see also, Hummels et al. 2011). The workers observed in the present study do not reflect those that have left manufacturing for other sectors or are unable to find work in any sector. Thus, it is likely that workers with lower levels of education are even more harshly affected by import competition than is demonstrated in this study, either through their wages or through their labor market options. However, this study does show that trade is a contributing factor to increased wage inequality in the U.S. No matter the aggregate gains from trade or how import competition may be helping certain workers, we need also to be concerned about its distributional effects.

This chapter has focused on the effects of import competition from low-wage countries on wage inequality, both between workers with different levels of formal education and within establishments between production and nonproduction workers. Certainly the production/nonproduction split is a very blunt tool for separating high- and low-skill workers. But education can also be a somewhat crude way of grouping workers. Both types of divisions are rough proxies for skill level, but both potentially blur which workers are most affected by low-wage import competition. The next chapter takes up this question, examining the relationship between import competition and the wages of workers who perform particular types of tasks.

Figures and Tables

Figure 1: Sign and Significance of Low-Wage Country Import Competition Coefficient on Wages, by Division, Year, and Education Level
(Low-Education = High School Diploma or Less; High-Education = Some College or More)

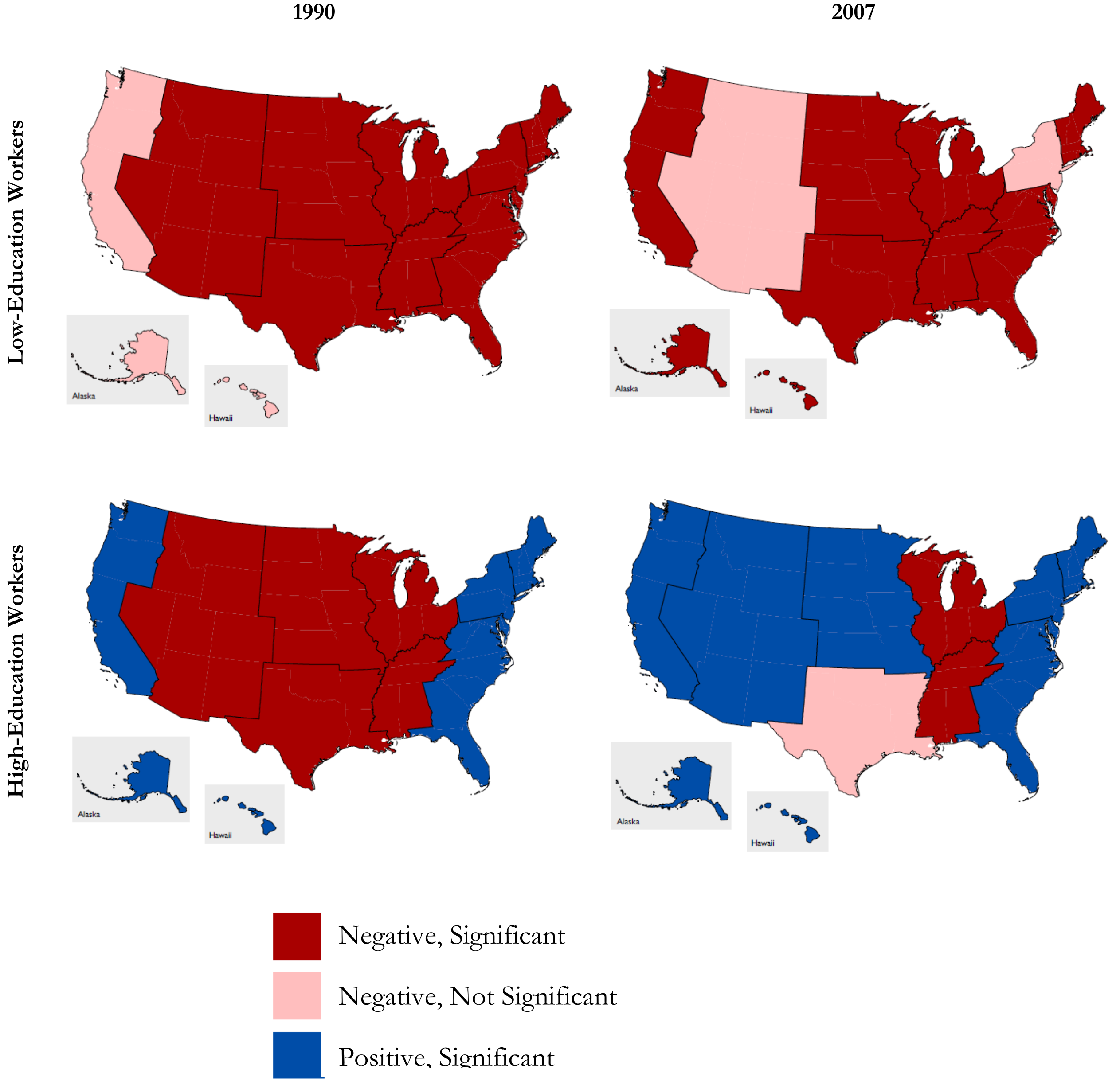

Table 1: Low-Wage Countries used in the Import Competition Measures

Afghanistan	Comoros	Haiti	Maldives	Sao Tome
Bangladesh	Congo	Honduras	Mali	Sierra Leone
Bhutan	Eqypt	India	Mauritania	Solomon Isl.
Benin	Equatorial Guinea	Indonesia	Mozambique	Somalia
Burkina Faso	Ethiopia	Kenya	Myanmar	Sri Lanka
Burundi	Gambia	Laos	Nepal	Sudan
Cambodia	Ghana	Lesotho	Niger	Tanzania
Central African Rep.	Guinea	Liberia	Nigeria	Togo
Chad	Guinea-Bissau	Madagascar	Pakistan	Uganda
China	Guyana	Malawi	Rwanda	Vietnam
				Zambia

NB: Classified according to the World Bank, using year 1992.

Table 2: Summary Statistics for Unmatched, Averaged Matched, and Unique Matched Samples of Full-Time-Full-Year Workers and Plants

Worker Characteristics	**All manufacturing workers (Decennial Census & ACS)**	**Averaged Match workers**	**Uniquely Matched workers**
Average annual nominal wages	31872.24	39615.95	37767.09
Average education category (1=high school diploma, 2=some college)	1.79	1.62	1.59
Average age	39.5	41	41
Percent male	63%	71%	72%
Percent US Born	91%	88%	91%
Percent white, non-Hispanic	83%	82%	84%
Percent working in a metro area	76%	81%	75%
Average percent foreign born with < H.S. Degree in year-state-industry	3.69%	5.33%	4.28%
Plant Characteristics	**All manufacturing plants (Census of Manufactures)**	**Averaged Match plants**	**Uniquely Matched plants**
TVS	20061.47	249452.70	250861.60
KL	91.31	107.68	111.37
Exports	1689.10	30065.36	25495.02
Computer Share of Investments	0.07	0.09	0.08

Note: All differences were evaluated between the averaged sample compared to each other sample. All differences are statistically significant at the 0.001 level, with one exception: The difference between the TVS values for the unique & averaged samples is not significant.

Table 3: Low-Wage Import Competition and Wages for Low- and High-Education Matched Workers with Averaged Establishments, National Models

	OLS		2SLS	
	(1) Low Education	(2) High Education	(3) Low Education	(4) High Education
Sex	9114.13	18786.34	9118.52	18762.58
	(64.55)***	(210.29)***	(64.66)***	(210.57)***
Nativity	4122.35	-122.84	4120.34	-75.83
	(120.68)***	(390.81)	(120.72)***	(391.68)
Ethnicity-Race Dummy	5011.03	14874.61	5008.36	14890.20
	(98.56)***	(333.16)***	(98.64)***	(333.07)***
Age	325.28	1007.50	325.36	1007.56
	(2.90)***	(10.47)***	(2.90)***	(10.47)***
Work In Metro	3154.25	8740.78	3159.31	8717.90
	(74.51)***	(280.60)***	(74.48)***	(280.83)***
State-Industry Percent Foreign Born Low Edu	-71.60	-307.77	-72.05	-292.86
	(6.69)***	(28.20)***	(6.68)***	(28.37)***
Total Value of Shipments	0.0022	0.0008	0.0022	0.0008
	(0.0001)***	(0.0001)***	(0.0001)***	(0.0001)***
Capital/Labor Ratio	2.64	1.09	2.63	1.11
	(0.39)***	(0.24)***	(0.39)***	(0.24)***
Value of Export Shipments	0.0009	0.0011	0.0009	0.0011
	(0.0003)***	(0.0004)***	(0.0003)***	(0.0004)***
Computer Share of Investment	-879.59	143.30	-866.96	141.47
	(155.56)***	(124.93)	(155.62)***	(124.73)
Import Competition	-7076.69	27013.31	-9246.74	43997.09
	(1,076.92)***	(2,862.74)***	(2,120.51)***	(5,614.36)***
Observations (rounded)	995000	479000	995000	479000
R-squared	0.18	0.15	-	-
F	901.61	352.78	874.18	352.88
Prob > F	0	0	0	0
Kleibergen-Paap rk LM (underidentification)	-	-	5693.15	1.60E+04
Chi-sq(1) P-val	-	-	0	0
Cragg-Donald Wald F (weak identification)	-	-	3.90E+05	1.60E+05
Kleibergen-Paap rk Wald F	-	-	2.50E+04	4.40E+04
Instrument	-	-	EU Imports	EU Imports

Robust standard errors in parentheses

** significant at 10%; ** significant at 5%; *** significant at 1%*

NB: Industry, State, and Year fixed effected included in all models

Table 4: Low-Wage Import Competition and Wages for Low- and High-Education Matched Workers with Unique Establishments, National Models

	OLS		2SLS	
	(1) Low Education	**(2) High Education**	**(3) Low Education**	**(4) High Education**
Sex (male=1)	8781.48	17727.32	8788.39	17731.41
	(83.64)***	(288.48)***	(83.62)***	(289.40)***
Nativity (US-born=1)	3826.27	-50.90	3818.06	-60.93
	(177.43)***	(601.22)	(177.80)***	(602.51)
Ethnicity-Race Dummy (non-Hispanic white=1)	4231.57	13166.39	4230.12	13167.85
	(140.02)***	(460.48)***	(140.01)***	(460.41)***
Age	314.03	1012.77	314.26	1012.80
	(3.68)***	(14.72)***	(3.69)***	(14.72)***
Work In Metro (metro=1)	2913.60	8344.62	2925.22	8353.45
	(87.20)***	(347.10)***	(87.31)***	(346.96)***
State-Industry Percent Foreign Born Low Edu	-66.88	-159.50	-68.20	-161.55
	(10.35)***	(41.13)***	(10.34)***	(41.41)***
Total Value of Shipments	0.0018	0.0006	0.0018	0.0006
	(0.0001)***	(0.0002)***	(0.0001)***	(0.0002)***
Capital/Labor Ratio	1.99	0.98	1.98	0.97
	(0.40)***	(0.26)***	(0.39)***	(0.26)***
Value of Export Shipments	0.0032	0.0010	0.0032	0.0010
	(0.0007)***	(0.0007)	(0.0007)***	(0.0007)
Computer Share of Investment	-1175.49	301.31	-1136.33	304.04
	(242.88)***	(247.50)	(243.14)***	(249.71)
Import Competition (LWICOMP)	-7801.33	19638.22	-12897.63	16436.44
	(1,183.97)***	(3,706.47)***	(2,768.74)***	(7,457.93)**
Observations (rounded)	517000	226000	517000	226000
R-squared	0.2	0.15	-	-
F	543.10	175.56	526.70	175.47
Prob > F	0	0	0	0
Kleibergen-Paap rk LM (underidentification)	-	-	2139.87	6635.75
Chi-sq(1) P-val	-	-	0	0
Cragg-Donald Wald F (weak identification)	-	-	1.40E+005	7.00E+004
Kleibergen-Paap rk Wald F	-	-	9125.29	1.60E+004
Instrument	-	-	EU Imports	EU Imports

Robust standard errors in parentheses

** significant at 10%; ** significant at 5%; *** significant at 1%*

NB: Industry, State, and Year fixed effected included in all models

Table 5: Low-Wage Import Competition and Nonproduction Wage Share for the U.S., Panel Model

	OLS (1)	GMM2S (2)
	-8.31e-09***	-3.63e-09
Total Value of Shipments	(2.66e-09)	(2.72e-09)
	8.99e-06	8.81e-06*
Capital/Value-Added Ratio	(5.96e-06)	(5.09e-06)
Value of Export Shipments	1.63e-08	1.59e-08
	(1.56e-08)	(1.78e-08)
	0.0004***	-0.001***
Plant Age	0.000	0.000
	-0.010***	-0.009***
Multi-plant Firm (Dummy)	(0.002)	(0.003)
Computer Share of Investment	0.026***	0.026***
	(.00269)	(0.004)
Related Party Trade with LWC	0.011***	0.013***
(Dummy)	(0.003)	(.00037)
LWICOMP	0.002***	0.164***
	(.00058)	(0.022)
Observations (rounded)	609000	609000
R-squared	.0098	–
F	11.91	10.99
Prob > F	0.000	0.000
Kleibergen-Paap rk LM (underidentification)	–	533.192
Chi-sq(1) P-val	–	0.000
Cragg-Donald Wald F (weak identification)	–	160.772
Kleibergen-Paap rk Wald F	–	607.516
Instrument	–	EU Imports

Robust standard errors in parentheses
** significant at 10%; ** significant at 5%; *** significant at 1%*
NB: Industry, State, and Year fixed effected included in all models

Table 6, Panel A: Sign and Significance of Import Competition coefficient on Wages, by Division, Year, and Education Level

Division 1: New England (CT, ME, MA, NH, RI, VT)	**1990**	**2000**	**2007**
< High school	-	-	- (*)
GED/ High school diploma	- (***)	-	-
Some college	-	+	-
College degree or more	+ (**)	+ (***)	+ (***)

Division 2: Middle Atlantic (NJ, NY, PA)	**1990**	**2000**	**2007**
< High school	- (***)	- (**)	-
GED/ High school diploma	- (***)	- (***)	-
Some college	-	+ (*)	+ (**)
College degree or more	+ (***)	+ (*)	+ (***)

Division 3: East North Central (IN, IL, MI, OH, WI)	**1990**	**2000**	**2007**
< High school	- (***)	- (***)	- (***)
GED/ High school diploma	- (***)	- (***)	- (***)
Some college	- (***)	- (***)	- (***)
College degree or more	+	- (***)	-

Division 4: West North Central (IA, KS, MN, MO, NE, ND, SD)	**1990**	**2000**	**2007**
< High school	- (***)	+	- (***)
GED/ High school diploma	- (***)	- (***)	- (***)
Some college	- (***)	- (***)	-
College degree or more	- (**)	+ (**)	+ (***)

Division 5: South Atlantic (DE, DC, FL, GA, MD, NC, SC, VA, WV)	**1990**	**2000**	**2007**
< High school	- (***)	- (***)	- (***)
GED/ High school diploma	- (***)	- (***)	- (***)
Some college	-	- (*)	-
College degree or more	+ (**)	+ (***)	+ (***)

The number of observations across each cell ranges from about 2000 to about 112000.
Results are from models run with state fixed effects and robust standard errors.
** significant at 10%; ** significant at 5%; *** significant at 1%*

Table 6, Panel B: Sign and Significance of Import Competition coefficient on Wages, by Division, Year, and Education Level

Division 6: East South Central (AL, KY, MS, TN)	**1990**	**2000**	**2007**
< High school	- (***)	- (***)	- (***)
GED/ High school diploma	- (***)	- (***)	- (***)
Some college	- (***)	- (***)	- (***)
College degree or more	+	- (**)	-
Division 7: West South Central (AR, LA, OK, TX)	**1990**	**2000**	**2007**
< High school	- (***)	- (***)	- (**)
GED/ High school diploma	-	- (**)	- (***)
Some college	- (**)	+	-
College degree or more	+	+ (***)	-
Division 8: Mountain (AZ, CO, ID, NM, MT, UT, NV, WY)	**1990**	**2000**	**2007**
< High school	- (**)	- (***)	-
GED/ High school diploma	- (***)	-	-
Some college	- (***)	+ (***)	+ (**)
College degree or more	+	+ (***)	+ (***)
Division 9: Pacific (AK, CA, HI, OR, WA)	**1990**	**2000**	**2007**
< High school	-	-	- (***)
GED/ High school diploma	+	-	-
Some college	+ (***)	+ (***)	+ (***)
College degree or more	+ (***)	+ (***)	+ (***)

The number of observations across each cell ranges from about 2000 to about 112000.
Results are from models run with state fixed effects and robust standard errors.
** significant at 10%; ** significant at 5%; *** significant at 1%*

Table 7, Panel A: Low Wage Import Competition and Nonproduction Wage Share by Census Division, Panel Models

	(1) Division 1	(2) Division 2	(3) Division 3	(4) Division 4	(5) Division 5
Total Value of Shipments	-2.87e-08 (3.45e-08)	-8.02e-09 (1.63e-08)	-1.55e-09 (7.33e-09)	-3.05e-08 (1.65e-08)*	1.74e-08 (1.47e-08)
Capital/Value Added Ratio	-0.003 (.0033)	-.0001 (7.89e-06)***	.0001 (.0002)	-.0001 (.0001)	0.00001 (1.21e-06)***
Value of Export Shipments	1.86e-07 (9.97e-08)*	-1.16e-07 (9.97e-08)	6.72e-08 (5.03e-08)	8.66e-08 (6.26e-08)	-1.32e-07 (1.23e-07)
Establishment Age	-.0013 (.0042)	-.0006 (.0018)	.0003 (.0003)	.0002 (.0006)	-0.01 (0.0054)
Multi-Unit Firm Identifier (multi=1)	-0.01 (.0081)	0.00 (.006)	-0.02 (0.0042)***	-0.01 (0.0071)*	0.02 (0.0453)
Low-Wage Related Trade Dummy	0.00 (.014)	0.01 (.0079)	0.00 (.0055)	0.00 (.010)	0.03 (.024)
Computer Share of Investment	0.04 (0.0197)*	0.03 (0.0113)**	0.02 (0.0049)***	0.03 (0.0082)***	0.03 (0.0184)*
Import Competition (LWICOMP)	0.12 (0.1576)	0.14 (0.0756)*	0.17 (0.0418)***	0.11 (0.0581)*	0.36 (0.1875)*
F	2.10	33.97	10.93	3.65	22.23
Prob > F	0.03	0.00	0.00	0.00	0.00
Kleibergen-Paap rk LM statistic (underidentification)	3.99	27.55	614.34	259.18	6.79
Chi-sq(1) P-val	0.05	0.00	0.00	0.00	0.01
Cragg-Donald Wald F statistic (weak identification)	1.21	7.37	8921.94	4644.54	1.55
Kleibergen-Paap rk Wald F statistic	3.96	28.68	1186.89	572.69	6.87
Instrument	EU Imports	EU Imports	EU Imports	EU Imports	EU Imports

Observations in this model are in the tens of thousands for each region
Robust standard errors in parentheses
** significant at 10%; ** significant at 5%; *** significant at 1%*
NB: Industry, State, and Year fixed effected included in all models

Table 7, Panel B: Low Wage Import Competition and Nonproduction Wage Share by Census Division, Panel Models

	(6) Division 6	(7) Division 7	(8) Division 8	(9) Division 9
	-1.60e-08	6.03e-09	6.33E-09	-1.37E-08
Total Value of Shipments	(1.90e-08)	(3.29e-09)*	(1.43e-008)	(6.37e-09)**
	-.00013	4.55e-005	0.00	0.00
Capital/Value Added Ratio	(0.0004)	3.14e-005	(0.0007)	(5.90e-005)
	(.0004)	-2.48e-08	0.00	0.00
Value of Export Shipments	(0.0000)	(6.11e-08)	(1.87e-08)	(3.24e-08)*
	-1.05e-07	-.0026	-0.001	0.0001
Establishment Age	(0.0009)	(0.0009)***	(0.0009)	(5.0e-004)
Multi-Unit Firm Identifier	9.89E-08	.0005	-0.02	-0.01
(multi=1)	(0.0086)	(.0082)	(0.0113)	(0.0057)**
	0.02	0.02	0.02	0.02
Low-Wage Related Trade Dummy	(0.0096)*	(0.0093)***	(.017)	(0.0077)**
	0.03	0.03	0.03	0.02
Computer Share of Investment	(0.0117)**	(0.0101)***	(0.0128)**	(0.0062)***
	0.13	0.25	0.14	0.15
Import Competition (LWICOMP)	(0.0786)	(0.0674)***	(0.0775)*	(0.0357)***
F	1.89	4.15	1.71	6.98
Prob > F	0.06	0.00	0.09	0.00
Kleibergen-Paap rk LM statistic (underidentification)	126.08	196.45	127.06	535.92
Chi-sq(1) P-val	0.00	0.00	0.00	0.00
Cragg-Donald Wald F statistic (weak identification)	32.46	67.41	2275.04	509.00
Kleibergen-Paap rk Wald F statistic	194.85	308.96	326.98	1214.41
Instrument	EU Imports	EU Imports	EU Imports	EU Imports

Observations in this model are in the tens of thousands for each region
Robust standard errors in parentheses
** significant at 10%; ** significant at 5%; *** significant at 1%*
NB: Industry, State, and Year fixed effected included in all models

Bibliography

Autor, D. H., D. Dorn, and G. H. Hanson. 2012. The China Syndrome: Local Labor Market Effects of Import Competition in the United States. *National Bureau of Economic Research Working Paper Series* No. 18054.

Baldwin, R. 2006. Globalisation: the great unbundling(s). Finland: Prime Minister's Office, Economic Council of Finland.

Berman, E., J. Bound, and Z. Griliches. 1994. Changes in the Demand for Skilled Labor within U. S. Manufacturing: Evidence from the Annual Survey of Manufactures. *The Quarterly Journal of Economics* 109 (2):367-397.

Bernard, A. B., J. B. Jensen, and P. K. Schott. 2006. Survival of the best fit: Exposure to low-wage countries and the (uneven) growth of U.S. manufacturing plants. *Journal of International Economics* 68 (1):219-237.

Chiquiar, D. 2008. Globalization, regional wage differentials and the Stolper-Samuelson Theorem: Evidence from Mexico. *Journal of International Economics* 74 (1):70-93.

Ebenstein, A., A. Harrison, M. McMillan, and S. Phillips. 2013. Estimating the Impact of Trade and Offshoring on American Workers Using the Current Population Surveys. *Review of Economics and Statistics*.

Feenstra, R. C., and G. H. Hanson. 1996. Globalization, Outsourcing, and Wage Inequality. *The American Economic Review* 86 (2):240-245.

———. 1999. The impact of outsourcing and high-technology capital on wages: estimates for the United States, 1979-1990. *The Quarterly Journal of Economics* 114 (3):907-940.

Frías, J. A., D. S. Kaplan, and E. A. Verhoogen. 2009. Exports Wage Premia: Evidence from Mexican Employer-Employee Data. *working paper*.

Grossman, G. M., and E. Rossi-Hansberg. 2006. The rise of offshoring: it's not wine for cloth anymore, 59-102.

Haskel, J. E., and M. J. Slaughter. 2002. Does the sector bias of skill-biased technical change explain changing skill premia? *European Economic Review* 46 (10):1757-1783.

Hummels, D., R. Jørgensen, J. R. Munch, and C. Xiang. 2011. The Wage Effects of Offshoring: Evidence from Danish Matched Worker-Firm Data. *National Bureau of Economic Research Working Paper Series* No. 17496.

Kemeny, T., and D. Rigby. 2012. Trading away what kind of jobs? Globalization, trade and tasks in the US economy. *Review of World Economics* 148 (1):1-16.

Kemeny, T., D. Rigby, and A. Cooke. 2013. Cheap Imports and the Loss of U.S. Manufacturing Jobs: SERC.

Kinney, S. K., J. P. Reiter, A. P. Reznek, J. Miranda, R. S. Jarmin, and J. M. Abowd. 2011. Towards Unrestricted Public Use Business Microdata: The Synthetic Longitudinal Business Database. *Center for Economic Studies Discussion Paper* 11 (04).

Krugman, P. R. 2008. Trade and Wages, Reconsidered. *Brookings Papers on Economic Activity* Spring.

Lawrence, R. Z., and M. J. Slaughter. 1993. International Trade and American Wages in the 1980s: Giant Sucking Sound or Small Hiccup? *Brookings Papers on Economic Activity* (2):161-226.

Mincer, J. A. 1974. Schooling, Experience, Earnings. *NBER*.

Troske, K. 1999. Evidence on the employer size-wage premium for worker-establishment matched data. *Review of Economics and Statistics* 81:15-26.

Chapter 4

International Trade and Returns to Tasks

4.1 Introduction

The past half-century has witnessed dramatic improvements in transportation technologies that have significantly reduced the cost of moving goods (e.g., Levinson 2006). During the same period, technological advances in communications fields have reduced the cost of information exchange allowing trade in services and giving firms greater capacity to control value chains that are increasingly distributed across far-flung corners of the globe (Bonacich and Wilson 2008; Gereffi and Korzeniewicz 1994). The rise of related-party trade, foreign direct investment flows, and the number of multinational corporation operations indicate that growing numbers of businesses are seeking newfound capacities to fragment production and exploit comparative advantages across developed and developing economies alike. Unlike traditional spatial divisions of labor based on finished goods such as those Ricardo described, or on monopolistic competition as analyzed by Krugman (1979), the contemporary reworking of the production and trade landscape involves a much finer-grained division of production possibilities that Baldwin (2006), Blinder (2006) and Grossman and Rossi-Hansberg (2006) tie to production tasks.

Simplistically, tasks are all the incremental steps of the production process necessary to design, test, construct, assemble, sell, and deliver intermediate goods and, eventually, final products. More specifically, Grossman and Rossi-Hansberg define tasks as “the finest possible addition to the value added of a good or service done by a particular factor of production”

(Grossman and Rossi-Hansberg 2012, p. 595), with the production of intermediate goods comprised of "bundles" of tasks.[16] The proliferation of task trade has relied on the ability to integrate and control distributed production networks, involving the efficient and cost-effective coordination of movement of goods, services, and information. This level of dispersion and coordination has become possible only relatively recently. Task trade is remapping large parts of the global trade network, increasing the number of nodes in the network as firms seek to exploit the potential gains that result from countries and cities developing their comparative advantage across subsets of a much larger set of production operations.

The concept of task trade has been particularly generative in understanding the patterns and implications of the growing phenomenon of trade in services. With cheaper and faster technologies for information exchange, services are increasingly amenable to production fragmentation and offshoring. Though services trade is growing, with U.S. imports and exports more than tripling between 1992 and 2012[17], the present research focuses on the import and export of manufactured goods. This is largely due to the limitations of available services trade data (Feenstra et al. 2010) but also because trade in merchandise is still far larger than trade in services. For example, in the past five years in the U.S., trade in services has been around 7% of GDP, while trade in merchandise has accounted for around 20 to 25% of GDP.[18] Though it has been particularly helpful in conceptualizing whether services can be offshored, the task trade concept is also useful in understanding the potential effects of the increasingly fine-grained fragmentation of production in manufacturing. The manufacture of most final goods now

[16] In earlier work, Grossman and Rossi-Hansberg say that the difference between tasks and intermediate inputs is "largely semantic" but that thinking in terms of tasks allows them to include heterogeneous trade costs into their model (Grossman and Rossi-Hansberg 2008, p. 1980)

[17] Bureau of Economic Analysis: www.bea.gov/newsreleases/international/trade/trad_time_series.xls.

[18] The World Bank: http://data.worldbank.org/indicator/TG.VAL.TOTL.GD.ZS/countries and http://data.worldbank.org/indicator/BG.GSR.NFSV.GD.ZS

involves the coordination of a series of intermediate inputs sourced from around the world before final assembly and sale to a consumer. Although trade in intermediate goods has been recognized for a number of years now (for example, Baldwin 2006; Coe et al. 2004; Dixit and Grossman 1982; Feenstra and Hanson 1996; Gereffi and Korzeniewicz 1994; Grossman and Rossi-Hansberg 2006, 2008; Helpman 1984), the insights from task trade help us think in new ways about the potential effects of this fragmentation of production across space as it becomes increasingly fine grained. For example, the "unpredictability" of who is affected by task trade identified by Baldwin (Baldwin 2006; Baldwin and Robert-Nicoud 2006) references a departure from the predictions of older trade models, even ones that accounted for intermediate goods trade. Furthermore, the fine grained level of competition in task trade makes clear that the effects will be located within firms and within groups of workers (particularly educational attainment groups) previously thought to share the same fate (Baldwin and Robert-Nicoud 2006).

Increasingly what can be traded is less about the product itself and more about the process necessary in making and delivering the product or parts of the product. Thus, to understand recent trade patterns, a key question is no longer what items (final goods or even intermediate parts) can be transported cost-effectively, but what tasks can be orchestrated over long distances. A body of literature has begun to identify several key characteristics of tasks that influence their importance in the production system and the ease with which they might be reproduced in different locations (e.g., Autor, Levy, and Murnane 2003; Baldwin 2006; Blinder 2006; Leamer and Storper 2001). Briefly, since this is covered in more detail in the next section, this body of work argues that it is possible to offshore tasks that are relatively routine, meaning tasks that can be described easily and clearly in codifiable language (written instructions, measurements, blueprints, etc...). In contrast, more complex tasks (those involving creativity, problem-solving, or judgment-based decisions) and tasks involving interpersonal interaction are more costly to coordinate and offshore. The intensity of these task characteristics (routineness, complexity, and interpersonal interaction) in different occupations means that certain occupations are more vulnerable to direct offshoring. I argue, consistent with recent research by others (e.g., Rigby et al. 2014, Ebenstein et al. 2013), that workers are more vulnerable to import competition from low-wage countries if the tasks they perform have these offshoring-vulnerable characteristics and yet remain onshore.

In the previous chapter I showed how increased import competition from low-wage countries increases inequality between workers with different levels of formal education. I also showed that increased import competition from low-wage countries is associated with a greater share of wages paid to nonproduction workers in U.S. manufacturing establishments. However, the task trade literature makes clear that production tasks in developed economies requiring high levels of formal education or skills are no longer "safe" from offshoring (Baldwin 2006; Blinder 2006). The characteristics that determine task trade vulnerability are only loosely correlated with traditional measures defining "good jobs" and "bad jobs," such as education level or whether a job requires manual labor or not. Thus, given the weakening of ties between general proxies for skill (education and production/nonproduction work) and the task characteristics that help determine whether specific jobs may be offshored (routineness, complexity, interpersonal interaction), it is also helpful to consider how the latter mediate the effect on wages from increased competition from low-wage countries.

In this chapter I examine the relationship between low-wage import competition and the wages of workers with different task characteristics that make their jobs more or less vulnerable to offshoring: routineness, complexity, and interpersonal interaction. To briefly preview the findings, this chapter shows that task intensity mediates the effect of low-wage import competition on workers' wages. It shows that import competition from emerging economies is associated with lower wages for workers with highly routine jobs and workers with jobs that have low complexity. It also finds that workers in jobs with low routineness and high complexity earn higher wages when there is greater low-wage import competition. Together, these effects on high- and low- task intensity workers have a polarizing influence on wages along a task-intensity continuum, rewarding workers at one end of the spectrum and penalizing workers at the other end. The trade and wage relationship mediated by interpersonal interaction task intensity is less straightforward. Workers in occupations with high levels of interpersonal interaction have higher wages when there is greater import competition from low-wage countries. Interestingly, the same is true for workers with the lowest levels of interpersonal interaction in their jobs. Only workers with medium-low levels of interpersonal interaction in their occupations suffer lower wages with increased low-wage import competition. These results suggest that we must account for characteristics other than sector or education level to more fully understand the relationship between trade and wages.

The remainder of this chapter proceeds as follows. Section 2 provides a brief review of the literature on task trade and labor market effects. Section 3 outlines an empirical model to capture the importance of task characteristics in describing the relationship between trade and wages. Data sources, variable construction, and a series of empirical concerns are discussed. Section 4 presents the results from estimating a series of related statistical models. Section 5 concludes, summarizing the key findings.

4.2 Task Trade and Labor Market Effects: A Brief Review of the Literature

Fragmentation of production across international boundaries has been increasing, prompting both new theoretical accounts of trade as well as new empirical observations and investigations. Much of the trade and wage literature reviewed in the previous two chapters relies on skill proxies such as educational attainment or the separation of manufacturing workers into production and nonproduction categories. These proxy measures have been useful and remain relevant. However, with the cheapness and speed of shipping and communication, growing populations of highly educated workers in low-wage countries, and increasing digitization of processes and products, some argue that education by itself is becoming a less reliable indicator of whether a person's job is vulnerable to trade (e.g., Baldwin 2006; Blinder 2006; Blinder and Krueger 2013). Hence, the literature on the characteristics of occupational tasks and their vulnerability to task trade is an important extension of the literature examining the impacts of trade.

In this section, I briefly sketch out the stakes of the increasing fragmentation of production for how trade and trade effects have been understood and modeled. I then discuss how task characteristics that determine vulnerability to offshoring have been conceptualized in the literature. The following section introduces the theoretical model used in the present research. Finally, I position my empirical work relative to other recent research on the impacts of task trade.

4.2.1 The Stakes of Intensified Production Fragmentation

Heckscher-Ohlin predicts geographical specialization arising from trade according to the factor abundance of each trading partner. Stolper-Samuelson extensions of Heckscher-Ohlin predict uneven returns to the factors in each place, with the abundant factor benefitting more. If the factors are skilled and unskilled workers then the skilled-labor abundant location will see relatively greater returns to skilled workers and the location relatively abundant in its supplies of unskilled-labor will experience greater returns to that factor.

Early conceptualizations of Heckscher-Ohlin were developed for a world where trade was dominated by exchange of final goods, and where specialization of production in countries occurred at the sectoral level. Within this simplified world, countries specialize in the production of particular sets of goods according to their relative demands for different factors of production. In those countries rich in a particular input, the sector(s) that use that resource intensively should enjoy relative growth. The impacts of trade were readily determined in this world by examining shifts in the relative wages of workers in different industrial sectors.

Our world today looks quite different, with production in any one industrial sector requiring inputs of many different types, including different types of labor. Thus, it has become much more difficult to identify entire industries as skilled-labor or unskilled-labor intensive. In understanding the effects of trade today, we can no long comfortably rely on observing the differences between sectors or broad skill groups or perhaps even between firms. Rather, the differences within sectors, within skill groups, and within firms are where the effects lie (Baldwin 2006, p. 17).

One of the primary reasons for this change has been a deepening division of labor and growing fragmentation of production for most commodities. Efficient production rarely involves individual firms making finished commodities from start-to-finish. Rather, the economic scope of most firms is rather limited, making a relatively small number of individual components that are often assembled by yet other specialized producers. The fragmenting of the production process means that there are components and tasks involved in even the most complex products that involve “low skill” labor. With task trade increasing, the previous one-to-one correspondence between the product and the labor involved now has a much more complicated calculus. So it is increasingly difficult to think simplistically about where products are made, since their production chains are often widely dispersed. Rather it is more helpful to think where particular types of tasks could be done.

4.2.2 Characteristics of Tasks that Make Them Vulnerable to Offshoring

Broadly, a body of work has begun to identify key characteristics of different tasks that influence the ease with which they might be reproduced in different locations. What these characteristics are, which are most important, how to measure them, and how many jobs in countries like the U.S. could be affected are issues still developing in the literature (e.g., see Blinder and Krueger 2013). Building from theoretical contributions on what makes a task vulnerable to offshoring, as well as on previous empirical work that operationalizes these concepts with existing data, I use three key task characteristics for this research: routineness, complexity, and interpersonal interaction.

Routineness is perhaps the most commonly used characteristic in task trade models. It is an intuitive characteristic related both to previously observed patterns of trade (e.g., the move of most of the garment and footwear production to low-wage countries) and to shifts in advanced economies in the relative decline of routine jobs and the rise of nonroutine jobs (e.g., Autor, Levy, and Murnane 2003; Goos and Manning 2007; Spitz-Oener 2006). Autor, Levy, and Murnane offered an early and influential definition of routineness: "a limited and well-defined set of cognitive and manual activities, those that can be accomplished by following explicit rules" (2003, p. 1280). Though their particular focus was on the potential for computerization of tasks, other scholars with an interest in task trade have followed their lead, arguing that routine tasks are relatively easily offshored (e.g., Grossman and Rossi-Hansberg 2006; Kemeny and Rigby 2012).[19]

Leamer and Storper (2001) also argue that routineness allows some tasks to be performed far away from the headquarters or management. But for them, the routineness is not necessarily a characteristic of the individual tasks themselves, but of the coordination between tasks. For example, can the tasks be coordinated with codifiable information or do they require more tacit information necessitating trust and understanding between the parties? Newly fractured production processes may technically be performed in any number of places, but coordinating all the parts can be costly enough to keep the task fragments located together, at least until the new process, or the coordination of the set of tasks, is routinized and codified. At that point, forces of deagglomeration disperse the tasks according to where they can be performed most cheaply. The newness of a fragmentation in a particular production process (Leamer and Storper, 2001) is not possible to observe directly in any of the data available to me. However certain aspects of the coordination factor are possible to capture in two further characteristics: complexity (also called nonroutiness) and interpersonal interaction.

Autor et al. define 'nonroutiness' in opposition to their characterization of routine tasks as involving "problem-solving and complex communication activities" (Autor, Levy, and

[19] The model Grossman and Rossi-Hansberg (2006) develop is agnostic as to what actually makes a task vulnerable to offshoring or not (e.g., p. 13), but their discussion of tasks tends towards the routine/nonroutine division. (e.g., p. 10-11).

Murnane 2003, p. 1280). However, I prefer Oldenski's (2011) related concept of 'complexity' as involving creativity, problem-solving, and decision-making, because it indicates that there are aspects of this concept that do not follow perfectly along a continuum from routine to nonroutine, but rather involve additional characteristics as well. This is helpful conceptually, but it also corresponds to the possibilities of constructing measures separately for routineness and complexity, which are negatively correlated, but not perfectly so. Oldenski offers the likelihood of problems arising that management must solve as determining which activities are likely to be actually offshored. She thus ties in some of the insights from Leamer and Storper that the coordination of the tasks is as important as the tasks themselves in determining what parts of the production process are not only technically footloose but likely to leave.

The interpersonal interaction characteristic speaks partly to the Leamer and Storper (2001) tacit coordination factor. It also draws in the personal/impersonal division Blinder (2006) develops with regard to the services sector. Blinder offers this distinction as the key factor in whether a task can be offshored, with impersonal services being those "that can be delivered electronically over long distances with little or no degradation in quality" (Blinder 2006, p.114). This concept is also applicable to business-service oriented occupations within the manufacturing sector, such as management jobs. This concept (whether a task is "interactive" or not) is also used by Becker et al. (2013) and Baumgarten et al (2013).

Recently Blinder and Krueger have proposed new survey-based measures of the "offshorability" of jobs in the U.S. based on survey responses to questions about type of business/industry, type of work/occupation, and the important activities or duties performed in a job (Blinder and Krueger 2013, p. S104). Interestingly, they find that their measure of vulnerability to offshoring does not align well with standard measures of routineness: "Thus, not only are the two criteria—routinizability and offshorability—conceptually different, as we have emphasized, they are not even positively correlated. The latter is certainly surprising" (p. S115). I expect that the measures of complexity and interpersonal interactivity used in the present study would correlate more closely with their measure of offshorability.

4.2.3 Theoretical Model

Beyond the models of trade and wages discussed in the previous chapter, there are a number of explicit models of task trade. There are some that develop offshoring models within a monopolistic competition framework, such as (Robert-Nicoud 2008). However, the one the present research draws most heavily upon is described in Grossman and Rossi-Hansberg (2008), where they develop a model of task trade in which what is traded, or offshored, is determined by weighing the costs of monitoring and controlling workers in another country against the potential savings from lower labor costs in that other country. The costs of coordinating workers from a distance are assumed to be lower for more routine tasks than for nonroutine tasks, and routine tasks are more likely to be performed by low-wage workers and nonroutine tasks by high-wage workers (e.g., Autor, Levy, and Murnane 2003). Reductions in trade costs, particularly communications costs, lead to increased offshoring of routine tasks.[20]

In this model, the increase in offshoring reduces costs and affects wages in the high-wage (onshore) country in three ways: through terms of trade effects (reducing the price of the imported goods since they are likely made by workers with lower wages); labor supply effects (with demand decreasing for workers with the task trade vulnerable characteristics), and; productivity effects (where the onshore workers refocus on higher-productivity tasks).

[20] They also develop a model of trade in tasks between countries with similar factor endowments (2012), however, since those trade relationships are not the particular focus of the present research, it is not closely reviewed here.

The aggregate effect of these three wage effects is not clear from the model itself. The first two effects suggest that (real) wages for workers in the home country will fall, but the third effect suggests that average wages could rise. It is likely that these three effects of offshoring impact workers differentially. Those workers least able (for a variety of reasons) to upgrade or respond to the new challenges of higher productivity tasks could still benefit from rising wages tied to average productivity increases, but are less likely to directly benefit from these shifts in general. This would suggest that *inequality* between workers most likely to adapt and those least likely to adapt should grow with increased task trade, even if there are general increases in welfare overall. This is hunch is confirmed in Rojas-Romagoas (2010) runs numerical simulations of the Grossman and Rossi-Hansberg model and finds that with nearly all combinations of endowments and robust to a wide a range of parameters, the model leads to increased inequality in the onshore, high-wage country.[21]

An interesting extension of the Grossman and Rossi-Hansberg model investigate the job destruction and creation effects of offshoring by relaxing the full-employment conditions often included in models like this and focusing on the productivity and job destruction effects of offshoring (Kohler and Wrona 2011). Kohler and Wrona find a non-monotonic relationship between offshoring and domestic employment. Jobs are destroyed as offshoring occurs, but the productivity effect can compensate for the job destruction effect in the long term under certain conditions. Though this article is an important contribution with respect to the lived effects of offshoring with respect to unemployment, its insights into distributional effects of offshoring are focused on returns to labor's wages versus capital's profits, rather than workers with differential vulnerability to offshoring. Under some instances, their model shows distributional effects that

[21] Rojas-Romagosa (2010) also finds increases in inequality in many numerical simulations in low-wage countries receiving offshored tasks, though in the low-wage countries, offshoring always increases welfare in aggregate.

favor labor, but it is not entirely clear how this might affect the wages of workers whose jobs are vulnerable to offshoring but that remain onshore.

Other models of task trade include Baldwin and Robert-Nicoud (2010), where they reproduce the basic Heckscher-Ohlin framework by adjusting how they think of the factor endowments of each country. They view offshoring as ‘shadow migration’ of endowments, meaning they imagine offshored work to be the equivalent of foreign factors moving to the home country, but still being paid the foreign country’s wages. When they do so, Stolper-Samuelson predictions hold for the home country, implying that in countries like the U.S., inequality in the wages paid to skilled- and unskilled labor should rise with increased offshoring.

4.2.4 Empirical Work

Much of the empirical work so far has focused on the shifts in demand for workers with different task-intensities. Though Autor, Levy and Murnane (2003) focus on the effects of computerization rather than trade, their work has been a generative approach to looking at demand for task-intensity. They found that in the face of increased computerization relative demand for jobs that involved routine, codifiable tasks decreased, whether they were manual or not. They found that increased computerization increased the relative demand for non-manual, nonroutine tasks. Their research on operationalizing the task characteristics using occupation descriptions is an important contribution. However, their study is also important since the pressures from computerization, replacing routine tasks and complementing nonroutine ones, function in much the same way as pressures from the offshoring decisions of multinational corporations (MNCs) or from import competition from low-wage countries.

One study that focused on the decisions by MNCs asked which tasks were offshored to foreign affiliates and which ones were done in the home country (Oldenski 2011). Oldenski posits that not everything that can technically be offshored is actually moved abroad. She applies the routine-nonroutine dichotomy to the offshoring decisions of multinational corporations, finding that U.S. MNCs were more likely to offshore routine tasks by having foreign affiliates perform them and more likely to keep complex and nonroutine tasks in the U.S.

Kemeny and Rigby (2012) develop a somewhat similar approach to Oldenski, but the question they pose has important differences. Instead of looking at the narrower effects of offshoring decisions of MNCs, they ask the broader question of what effect trade from low-wage countries has on the demand for occupations with different task characteristics. Their work captures the important effects of task trade that are accomplished through arms-length transactions, rather than solely those that happen within the enterprise boundaries of MNCs. They find that import competition from low-wage countries increases sector-specific demand for nonroutine tasks. Using disaggregated components of their nonroutine measure, they find that the interpersonal interaction and nonroutine analytical tasks are positively related to increased demand in the face of increased import competition. Interestingly, they find that demand for nonroutine manual tasks is negatively related to import competition. Similar work has been done using data from outside the United States. Research has shown evidence of 1) shifts in Germany in the nonroutine-routine worker ratio as related-party trade with developing countries increases (Becker, Ekholm, and Muendler 2013), 2) skill-upgrading in the face of trade in Belgium (Mion and Zhu 2013) and Argentina (Bustos 2011), and 3) production job losses in France from imports (Biscourp and Kramarz 2007).

Together these papers advance our understanding of the shifts in demand for tasks with various offshoring-vulnerable characteristics. Less studied is how these shifts in demand translate into worker impacts. A few important exceptions exist, such as Ebenstein et al. (2013), Baumgarten et al. (2013), and Hummels et al. (2011).

The work of Ebenstein et al. (2013) examines the effect of offshoring from U.S. MNCs on the wages of U.S. workers, focusing not on industry-level exposure to globalization, but rather on occupation-level exposure. They find that offshoring to low-wage countries lowers the wages of U.S. workers with routine jobs. Offshoring to high-wage countries has the opposite effect on these workers, raising the wages of those who perform routine tasks. Overall, the net effect of offshoring on the wages of workers with routine jobs is negative, largely through the reallocation of workers from high-wage industries to lower-wage industries. They also find that for workers with the least routine jobs, increased offshoring is associated with higher wages.

Baumgarten et al. (2013) examines the offshoring impacts on individuals' wages in Germany, paying particular attention to how the task characteristics of a worker's occupation mitigate negative impacts of offshoring, even net of their education level. They find substantial negative wage effects from offshoring, particularly when they allow for cross-industry offshoring effects, essentially assuming that workers can find work in their chosen occupation in a number of industries. They also find that high intensity of non-routineness or interactivity in occupations mitigates the negative wage effects of offshoring, offering some level of protection to the workers in occupations with high levels of those characteristics.

Hummels et al. (2011) also address the question of the effects of offshoring on individual wages, including specifically looking at the role of tasks in moderating these affects.

Using Danish matched employer-employee data, they find that routine occupations (within skill groups) are associated with wage losses from offshoring.

The present chapter aims to show that these shifts in demand for different task intensities translate into shifts in wages for the workers who perform those tasks. It constructs an empirical model to test how task intensities in routineness, interpersonal interaction, and complexity mediate the effect of low-wage import competition on wages in the U.S. This chapter builds on previous research to make several contributions. It observes the wage effects of the impacts of trade on task demand identified by Kemeny and Rigby (2012). It complements the work of Ebenstein et al. (2013) by examining the wage effects not only associated with a measure of routineness, but also two other key task characteristics of interpersonal interaction and complexity. It also complements Baumgarten et al. (2013) and Hummels et al. (2011) by offering a somewhat similar analysis using the case of the U.S. Finally, it includes establishment-level characteristics as control variables on the individual wages outcomes, something not possible without matched employer-employee data and thus not included in much of the previous research (with Hummels et al. 2011 as an important exception).

4.3 Empirical Strategy

I seek to measure the extent to which rising import competition from low-wage countries is associated with changes in the wages of workers in occupations with particular task-intensity characteristics. The analysis rests on two assumptions. First, that commodity imports from low-wage countries embody routine labor functions that compete with U.S. labor with the same task characteristics, lowering the wages of U.S. workers with those characteristics. Second, that commodity imports from low-wage countries complement work done by U.S. workers with tasks that are high in interpersonal interaction and that involve high complexity in creativity, decision-making, and problem-solving. I expect this complementary relationship to raise the wages of U.S. workers in occupations with high task-intensity in interpersonal interaction and complexity.

To model these relationships, I adapt the specification used in Chapter 3. The basic model for the employer-employee approach relates individual reported annual wages to low-wage import competition and several control variables:

$$W = f(PERSON, ESTAB, MIGRATION, SBTC, TASK\ INTENSITY, LWICOMP) \qquad (1)$$

where *W* represents the annual wages of a worker, *PERSON* represents the worker's demographic characteristics, including education level, *ESTAB* represents the plant characteristics where the worker is employed, *MIGRATION* represents the regional low-education migration context, *SBTC* represents skill-biased technological change, *TASK INTENSITY* is the level of a particular task necessary in the worker's occupation, and *LWICOMP* represents import competition from low-wage countries.

4.3.1 Data and Task Intensity Construction

The base data utilized to examine how task characteristics mediate the relationship between trade and wages are the matched employer-employee data described in detail in Chapter 3. These data are constructed from the confidential versions of the U.S. Census Bureau's Decennial Census, American Community Survey (ACS), and Census of Manufactures (CMF). Manufacturing workers in the Decennial and ACS are matched to establishments in the CMF based on industry and census tracts. Where there is not a unique match to an establishment because there is more than one plant with the same industry in a Census tract and year, the characteristics of the establishments within the industry and Census tract are averaged into a synthetic plant.

Following the trade-wage models of the previous chapter, the main independent variable of interest is import competition from low-wage countries (LWICOMP). The variable is constructed in the same manner as defined in Chapter 3:

$$LWICOMP_{it} = \frac{IMPORTS_{it}^{LWC}}{IMPORTS_{it} + SHIPMENTS_{it} - EXPORTS_{it}} \qquad (2)$$

where $IMPORTS_{it}^{LWC}$ is the value of imports in industry *i* and time *t* for low-wage countries and $IMPORTS_{it}$ is the value of imports for all countries; $SHIPMENTS_{it}$ is the total domestic production (shipments) and $EXPORTS_{it}$ represents U.S. exports.

An important addition to the data used in the Chapter 3 is the occupational characteristics or job attributes of each worker. O*NET (Occupational Information Network) is a publicly available dataset from the U.S. Department of Labor that gives descriptors of different characteristics of occupations, based on surveys of workers in each occupation.[22] O*NET provides a multifaceted picture of the job and worker characteristics associated with defined occupations. Of particular interest in the present chapter are the work activities detailed as part of the Occupational Requirements domain of the overall O*NET content model. The work

[22] O*NET Resource Center: http://www.onetcenter.org/; O*NET Revision 14

activities correspond most closely to the conceptions of tasks developed in the theoretical literature and follow previous empirical work using O*NET (Oldenski 2011).[23]

To generate measures of task-intensity for each occupation, I use principal components analysis to reduce several work activities down to individual measures of particular task characteristics. The input variables and the constructed primary components are summarized in Table 1. Following Oldenski, I create a single measure of routine manual labor using the primary component among performing general physical activities, handling and moving objects, and controlling machines and processes. I depart from Oldenski's nonroutineness measure that incorporates both creativity and communication, opting instead for two separate measures. The first captures analytical and decision making tasks ("complex") built from a combination of analyzing, decision making and problem solving, creative thinking, and objectives and strategies development. The second is a measure of interpersonal interaction intensity, based on communications, relationship management, conflict resolution, and consulting and advising others.

Table 2 shows the task intensity scores for several occupations to help ground these concepts in some concrete examples. Below each task intensity measure (routineness, interpersonal interaction, and complexity) are the component dimensions. The component dimensions are measured on a scale from 0 to 1. The task intensity measures are transformed so that the entire range is always a positive number. Note that the scales for each task intensity measure are not comparable. From these example occupations, the managerial occupation (Column 1, industrial production manager) is a much less routine and more complex job and one that requires much more interpersonal interaction than the other occupations. The machine

[23] In an interesting alternative approach, Becker et al. (2013) (and following them, Baumgarten et al. 2013) base their measures of the intensity of the tasks "non-routine" and "interactive" off of the tools commonly used in each occupation.

operators (Column 4, cutting/pressing/punching machines and Column 5 sewing machines) have higher routineness intensities and lower complexity and interpersonal interaction.

Once constructed, I linked the three occupation-specific task intensity scores to individual workers based on each individual's occupation as reported in the Decennial and ACS. The resulting dataset is a pooled cross-section (1990, 2000, and 2007) that includes over 1.6 million individuals. For each individual, I have annual wages and basic demographic characteristics, including educational attainment. To these characteristics I add the intensity of routineness, complexity, and interpersonal interaction on the job, based on each person's occupation. Establishment characteristics where each individual works are also included. Finally, industry-year import competition from low-wage countries is attached to each individual. This dataset allows me to model the effect of low-wage import competition on the wages of workers with different occupational proclivities, net of the effects of education, demographics, and establishment characteristics.

For the entire analytical sample, Table 3 shows the means, standard deviations, and the correlations among the task intensity measures, wages, computer share of investment, education categories, and low-wage import competition. Routineness is negatively correlated with both complexity and interpersonal interaction. Routineness is also negatively correlated with wages, whereas complexity and interpersonal interaction are positively correlated with wages.

4.3.2 Estimation

The aim of the analysis is to explore how different task intensities mediate the relationship between low-wage country import competition and the wages of U.S. manufacturing workers. A series of regression models is employed for this task. The dependent variable in these models is annual wages and observations correspond to individual workers over the years examined.

The wage models of Chapter 3 are extended in this analysis, with two important modifications. First, explicit attention is paid to worker education by incorporating a measure reflecting years of schooling on the right-hand side of equation (4). Second, workers are placed into quartiles according to where there occupation lies along an index of task intensity. This process is repeated for the three task dimensions generated – routineness, complexity, and interpersonal interaction. While the quartiles are themselves an arbitrary grouping, this specification makes interpretation of the effects relatively easy. Equation (3) outlines the base model specification.

$$W_{jto} = \alpha + \boldsymbol{\beta}'_u \boldsymbol{P}_{ujgt} + \boldsymbol{\beta}'_v \boldsymbol{E}_{vkt} + \beta_1 M_{jits} + \beta_2 SBTC_{kt} + \beta_3 LWICOMP_{it} + \delta_t + \delta_i + \delta_s + \varepsilon_{jit} \quad (3)$$

where W_{jto} is the wage of worker *j* in time *t* in group *o* of a particular task; $\boldsymbol{P}_{jgt}$ is a *u*-element vector of worker characteristics for worker *j* in group *o* of a particular task intensity, including age, sex, nativity, and race-ethnicity, and education level; $\boldsymbol{E}_{kt}$ includes a *v*-element vector of features of establishment *k*, establishment size, capital-labor ratio, and value of exports; M_{jits} is a measure of the prevalence of low-education immigrant workers in the industry and state of the worker; $SBTC_{kt}$ is an establishment-specific measure of the share of investments made by that establishments in computers, capturing skill-biased technological change arguments; $LWICOMP_{it}$ is the measure of import competition from low-wage countries, specific to each industry and year. This specification also includes three fixed effects terms: δ_t is a year dummy that accounts for business cycle dynamics; δ_i is an industry fixed effect that captures sector-specific wage shocks unrelated to trade; δ_s absorbs state-specific shocks. Finally, ε is an error term that is assumed to satisfy classical regression assumptions.

I estimate these equations as pooled cross-sections using ordinary least squares. However, those results could be biased if LWICOMP is correlated with sector-specific demand or productivity changes in the U.S. not captured elsewhere in the model. As in the previous chapter, to account for this potential endogeneity bias, I instrument for LWICOMP using a measure of year- and industry-specific imports into the EU-15 European nations from the same low-wage countries used in the LWICOMP construction in equation (3). This measure is constructed from the United Nations COMTRADE data. The logic of this instrument assumes that the European countries face similar exposure to low-wage import competition when imports reflect factors inherent in low-wage countries, or in the dynamic of trade between low-wage and high-wage countries, but that demand side factors in domestic wages should be relatively uncorrelated across different countries. This instrument, used in specifications employing two stage least squares, should help give estimates of the exogenous effect of low-wage import competition on wages in U.S. manufacturing.

4.4 Results

4.4.1 Routineness, Low-Wage Import Competition, and Wages, by Quartiles

I estimate equation (3) for groups of workers that fall into quartiles of each task intensity measure. Thus, I estimate wages using OLS (Panel A) and two-stage least-squares (Panel B) for workers in occupations with low, medium-low, medium-high, and high task intensity measures. Every model includes state, industry, and year fixed effects. This process is repeated for each of the three task intensity measures. The first results reported are for workers grouped by the level of routineness in their occupations.

Table 4, Panel A reports estimates of the relationship between low-wage import competition and wages for workers grouped by the level of routineness in their occupations. The first column reports the results for low-routineness workers, meaning workers with occupations that score low on moving and handling objects, general physical activities, and controlling machines. For these workers, low-wage import competition, LWICOMP, is positively related to their wages, showing a rise in wages with increased LWICOMP. This fits with the expectations based on the theoretical model. The establishment characteristics produce results that are somewhat more mixed. Interestingly, computer share of investment and the value of export shipments are both negatively related to wages for this group of workers, though the coefficients are not significant for either covariate. The size of the establishment measured by shipments and the capital/labor ratio of the plant are positively and significantly related to wages, as expected. The demographic characteristics are generally in line with expectations: being male, older, white and non-Hispanic, and having higher levels of formal education are all associated with higher wages. Interestingly, for this group, being born in the U.S. is negatively and significantly associated with wages, suggesting that native born workers in this group with low-routine task intensity are earning less than their foreign born counterparts. Finally, the contextual variables operate much as expected. Working in a state and industry with a high percentage of low-education foreign born workers is also associated with lower wages. And working in a metro area is positively associated with higher wages.

The second column reports the results for workers with occupations with medium-low routineness intensity. For this group of workers, low-wage import competition is positive, but not significant. In the context of the other groups of workers, I interpret this result to mean that the medium-low intensity group encompasses the hinge point in the routineness measure, where the effect shifts from protecting and enhancing workers' wages (low routineness) to lowering workers' wages (high routineness), a result discussed next.

For workers with medium-high routineness intensity (Column 3) and workers with high routineness in their occupations (Column 4), low-wage import competition is negatively and significantly associated with wages. For both of these groups of workers, the demographic, establishment, and contextual characteristics operate as expected. Notably, computer share of investments also works as we might expect. The association with wages is negative and significant, indicating that in establishments with higher levels of investment in computers, workers with highly routine occupations receive lower wages. This is perhaps an indication of capital-labor substitution for less-skilled workers and workers with more routine jobs.

Note, however, that the coefficient for LWICOMP is much smaller in Column 4 (highest routineness) than in Column 3 (med-high routineness). This is unexpected and difficult to understand exactly what might account for this. It is possible that a portion of the jobs that are the most routine are not as directly affected by trade because they require physical presence and cannot be as easily offshored. This might be an artifact of the input variables used to construct the measure of routineness, which skew towards manual labor. It is also possible that some of these workers are removed enough from direct production, say janitors and packers, that they are somewhat shielded from the trade effects. It is also possible that stickiness of wages dampens and downward pressure on wages for this group if wages are already low. It is also possible that this is evidence that routineness on its own is not the best measure of vulnerability to offshoring, as Blinder (2013) argues.

Table 4, Panel B presents results for the same groups as Panel A, but estimated using two-stage least-squares fixed effects estimators. In these models, I use the EU imports as an instrument for LWICOMP. The diagnostics reported at the bottom of the table suggest that the instrument is not weak. This instrument helps me estimate the exogenous effect of low-wage import competition on wages. In all models the first stage diagnostics reported at the bottom of the table indicate the suitability of the instrument. The Kleibergen-Paap K-P rk LM Chi-squared/p-value statistics indicate that the instrumented model passes this underidentification test. The Kleibergen-Paap (K-P) F-statistic reports on the instrument relevance. I conclude that the instrument is relevant and not weak since the value is well above the Stock-Yogo critical values. Unfortunately with only one instrument, I cannot report statistics relevant to overidentification and thus discuss the exogeneity of the instrument (e.g., Hanson's J).

The results in these models are broadly similar to the results from the OLS estimation. Differences of note include coefficients for low-wage import competition that are larger in the first three categories (low to medium-high routineness). In the case of the least routine jobs (Panel B, Column 1), the size of the coefficient roughly doubles in the 2SLS model compared to the OLS model (Panel A, Column 1). Also of note is that the relationship between low-wage import competition for wages of workers with the most routine jobs (Panel B, Column 4) is negative, as it was in the OLS results (Panel A, Column 4), however it is not significant at even the ten percent level. This result is not predicted, however, it is not entirely surprising given the much smaller LWICOMP coefficient in the OLS models for this group (Panel A, Column 4).

It is difficult to assess which set of regression coefficients provides the best estimates of the influence of import competition between the two Panels of Table 5. The OLS results might be compromised with some endogeniety issues. However, use of instrumental variables also generates some bias in estimated coefficients. In addition, the relatively large standard errors in the 2SLS models – they are roughly double the size of the LWICOMP standard errors in the OLS models – also suggests loss of precision in estimation. Regardless, the two sets of results are broadly consistent with each other and indicate that for workers with the least routine occupations, imports from low-wage countries are complementary to their work and increase their wages. The opposite is true for workers with more routine jobs. For these workers, import competition is generally associated with lower wages.

4.4.2 Complexity, Low-Wage Import Competition, and Wages, by Quartiles

Turning to the second type of task intensity, Table 5, Panels A and B, present results from estimations of the relationship between low-wage import competition and wages for workers grouped by the complexity of their occupations. Recall that the intensity of complexity here includes elements of creative thinking, analysis, problem-solving, decision-making, and developing objectives and strategies. The order of the columns is the same as the previous tables, with lowest intensity in Column 1 and highest intensity in Column 4. However, because complexity is negatively correlated with routineness, the intuition of which workers will be negatively affected by trade competition is reversed in these tables. Here, the least complex jobs (Column 1) are likely to be the most vulnerable to negative impacts of trade competition, while the most complex jobs (Column 4) should be complemented by low-wage import competition and thus see their wages rise with increased trade competition.

In Table 5, Panel A, Column 1, which reports the OLS results for the group of workers with the lowest-complexity jobs, low-wage import competition is negatively and significantly associated with wages. Thus, in the face of greater import competition from low-wage countries, these workers receive lower wages. As the complexity required in occupations increases beyond this lowest quartile, the relationship is reversed. In Columns 2 through 4, with results for groups with progressively greater complexity in the tasks performed, the relationship between low-wage import competition and wages is positive and significant. So for these workers, increased low-wage import competition is associated with higher wages.

The other covariates operate in much the way we might expect, with two notable features. The first is that for the group with the most complex jobs, nativity is negatively and significantly associated with wages, meaning that U.S. born workers have lower wages than their foreign-born counterparts. For the other groups of workers, in jobs that are less complex, being born in the U.S. is associated with significantly higher wages. The other notable feature is the negative relationship between computer share of investment and wages for all groups. However, note that the effect is larger for lower complexity jobs and is small and not statistically significant for the highest complexity group. This is consistent with the idea that computer investment substitutes for labor in less complex tasks. However, if skill-biased technical change were operating strongly, we would also expect to see the wages (revealing productivity) of workers with the most complex jobs increase.

In the two-stage least-squares models shown in Table 5, Panel B the results are consistent with the OLS results. The first-stage test statistics lead me to conclude that the model is not underidentified and that the instrument is not weak. The notable difference between the two sets of results is that the coefficient on LWICOMP for the 2SLS models are roughly double what they are in the OLS results. The standard errors for LWICOMP in the 2SLS models are also roughly double what they are in the OLS models.

4.4.3 Interpersonal Interaction, Low-Wage Import Competition, and Wages, by Quartiles

Finally, turning to the third type of task intensity: interpersonal interaction. Table 6, Panels A and B, report results of estimations of the relationship between low-wage import competition and wages for workers grouped by how important interpersonal interaction is in their occupations. Again, the structure of the table is the same as the previous tables.

Table 6, Panel A, Column 1 reports results for workers with low interpersonal interaction intensity in their occupation. Contrary to expectations, low-wage import competition has a positive and significant association with wages for this group. In this group, the low levels of interpersonal interaction (communicating with people outside the organization, establishing and maintaining personal relationships, resolving conflicts, and providing consultations and advice) would seem to fit with the idea that imports from low-wage countries could be competitive rather than complementary for these workers. But this is not what the results suggest for this particular group of workers. For the other groups of workers, however, the results support the idea that interpersonal interaction intensive jobs should be less vulnerable to offshoring, and therefore also more likely to benefit from low-wage imports. In Column 2, the medium-low intensity group displays a negative and significant relationship between LWICOMP and wages. In Columns 3 and 4, showing the groups with higher intensity of interpersonal interaction in their occupations, low-wage import competition is positively and significantly related to wages. The other covariates operate as expected.

The instrumented 2SLS results (Table 6, Panel B) have the same pattern as the OLS results, and again the first-stage test statistics lead me to conclude that the model is not underidentified and the instrument is not weak. Workers with the lowest intensities of interpersonal interaction have higher wages in the face of increased low-wage import competition (Column 1), the medium-low group has lower wages (Column 2), and the two groups with the most interpersonal interaction have higher wages (Columns 3 and 4) with higher LWICOMP. For each group, the coefficient on LWICOMP is statistically significant. Among all of these groups, the 2SLS results have much larger coefficients on low-wage import competition than the OLS results (Panel A).

The unexpected sign on the LWICOMP coefficient for the workers with the least interpersonal interaction is not easy to explain. It is possible that the variables used to construct the measure of interpersonal interaction are missing a crucial aspect of vulnerability to offshoring. The variables used give a good sense of the necessity of face-to-face communication, but they do not capture the necessity of physical presence that might not require communication. Janitors might be a good example again. They do not necessarily need to talk much to do their jobs effectively and so would score low on the interpersonal interaction measure, but they also cannot email or ship their work in from another country. So it is possible that this constructed measure of interpersonal interaction is not capturing everything it is intended to. It is also possible, however, that these findings are valid. They are consistent with some of the literature looking at the polarization in the workforce in countries like the U.S and U.K., where employment and wages are gaining at the very top and very bottom of the wage spectrum, but ‘hollowing out’ in the middle (e.g., Goos and Manning 2007).

4.4.4 Interacting Low-Wage Import Competition and Task Characteristics

In addition to running the model on subsets of workers based on the intensity of the three task characteristics, I also ran the model three separate times on all the workers pooled together and included a variable interacting LWICOMP and each task intensity measure (results not shown here for brevity). The results reveal that the effect of LWICOMP is greater as task intensity increases. Thus, net of the effect of LWICOMP and routineness by themselves, LWICOMP has a larger negative effect on wages as routineness increases. More routine occupations are more negatively affected by trade competition. Complexity and interpersonal interaction show the same pattern, but with the sign reversed to reflect their positive association with wages. The interacted term shows that as the complexity, or level of interpersonal interaction, increases, the positive effect on wages from LWICOMP also increases. The coefficients on these variables – LWICOMP, the task intensity measure, and the interaction between the two – are all statistically significant at the 1% level.

4.5 Conclusion

An important feature of the changes in international trade over the past few decades is increasing fragmentation of production processes across countries linked by trade transactions, referred to as task trade. One of the key implications of this fine-grained fragmentation is that it changes what can conceivably be separated out of the production process and produced elsewhere. This specialization of production in different countries linked by trade is now occurring at the level of tasks and no longer at the level of sectors. Education and production/ nonproduction status among workers clearly captures something about how workers are affected by trade (as we saw in the last chapter). But these categories are no longer the only way to conceptualize and measure vulnerability to trade competition. It is also helpful to think about other ways the effects of trade might be 'visible.'

To address this, I examine the effects of trade on workers not by broad skill groups, proxied by education or production/nonproduction status, but based on the intensity of key task characteristics in occupations. This chapter asks how different tasks' intensities mediate the relationship between low-wage import competition and wages of U.S. manufacturing workers. It finds that low-wage import competition is associated with lower wages for workers with highly routine jobs and workers with low complexity intensity jobs. It also finds that workers in jobs with low routineness and those with high complexity earn higher wages when there is greater low-wage import competition. Looking at interpersonal interaction, this chapter provides a slightly less straightforward finding. Workers with the lowest and highest levels of interpersonal interaction in their occupations receive higher wages in the face of higher import competition, but workers with medium-low intensity of this characteristic have lower wages with greater import competition.

In general, these results suggest that workers who perform tasks that are theoretically more vulnerable to offshoring and task trade also face negative wage effects associated with low-wage import competition. These results also show that the effects of trade are not linear. As with the differential effect on high- and low-education workers, import competition modifies workers' wages depending on the task characteristics of their occupation. At least for routineness and complexity (it is a little less clear what is happening with interpersonal interaction), it appears that the proportion of workers affected negatively or positively is skewed. Only the lowest quartile of workers based on complexity suffer lower wages, but half of workers with more routine jobs have significantly lower wages. Only the lowest quartile of workers based on routineness have benefited from higher wages, but three-quarters of the workers grouped by complexity have higher wages in the face of increased import competition. The size of the group of workers who are potentially affected by import competition based on a particular task characteristic varies.

This chapter and the last chapter have focused on the effect of trade on workers' wages, particularly focusing on how workers with different characteristics (education, production/ nonproduction status, or task characteristic intensity) are variably affected by import competition from low-wage countries. But the impacts of trade do not operate at a single scale or on a single type of actor. It is also important to look at trade effects at the level of the establishment. The next chapter looks at the effect of low-wage import competition on the likelihood of manufacturing plant closure.

Tables

Table 1: Variable Construction - Principal Component Analysis Variables

	Component Variables from O*NET
Routine	Performing General Physical Activities
	Handling and Moving Objects
	Controlling Machines and Processes
Complex	Analyzing Data or Information
	Making Decisions and Solving Problems
	Thinking Creatively
	Developing Objectives and Strategies
Interpersonal interaction	Communicating with Persons Outside Organization
	Establishing and Maintaining Interpersonal Relationships
	Resolving Conflicts and Negotiating with Others
	Provide Consultation and Advice to Others

Table 2: Selected Occupations with Task-Intensity Measures and Their Component Dimensions

	(1) Industrial Production Managers	(2) Electrical, Electronics, and Electromechanical Assemblers	(3) Butchers and Other Meat, Poultry, and Fish Processing Workers	(4) Cutting, Punching, and Press Machine Setters, Operators, and Tenders, Metal and Plastic	(5) Sewing Machine Operators
Routine	**9.685**	**10.956**	**10.883**	**11.250**	**10.296**
Performing General Physical Activities	0.400	0.639	0.680	0.643	0.475
Handling and Moving Objects	0.410	0.754	0.788	0.773	0.555
Controlling Machines and Processes	0.403	0.646	0.510	0.830	0.588
Complez	**10.774**	**9.025**	**8.381**	**8.662**	**8.346**
Analyzing Data or Information	0.540	0.355	0.293	0.300	0.275
Making Decisions and Solving Problems	0.828	0.613	0.488	0.538	0.483
Thinking Creatively	0.635	0.440	0.268	0.315	0.298
Developing Objectives and Strategies	0.595	0.268	0.278	0.318	0.255
Interpersonal interaction	**11.261**	**8.933**	**8.643**	**7.935**	**8.108**
Communicating with Persons Outside Organization	0.603	0.230	0.250	0.165	0.158
Establishing and Maintaining Interpersonal Relationships	0.790	0.589	0.423	0.358	0.430
Resolving Conflicts and Negotiating with Others	0.788	0.345	0.364	0.223	0.200
Provide Consultation and Advice to Others	0.540	0.276	0.297	0.205	0.238

Table 3: Means, Standard Deviations, and Correlations for Occupational Characteristic Sample

	Mean	S.D.	Wage	Comp. Share of Invest-ments	Edu. Category	LWI-COMP	Complex	Routine	Inter-personal Inter-action
Wage	40796.59	39703.08	1						
Computer Share of Investments	0.094	0.322	0.020	1					
Education Category	1.664	1.125	0.351	0.035	1				
LWICOMP	0.036	0.067	0.029	0.043	-0.001	1			
Complex	9.931	0.924	0.345	0.028	0.441	-0.032	1		
Routine	10.070	1.033	-0.282	-0.043	-0.497	-0.067	-0.532	1	
Interpersonal Interaction	9.757	1.087	0.330	0.024	0.425	0.001	0.757	-0.709	1

Table 4, Panel A: Routineness and LDC Import Competition - Relationship to Wages - OLS Models

	(1)	(2)	(3)	(4)
	Low Routineness	Med-low Routineness	Med-high Routineness	High Routineness
Sex, 1=male	23154.21	15773.54	8714.12	7716.48
	(206.92)***	(144.52)***	(87.00)***	(114.55)***
Nativity, 1=US born	-2066.17	-566.52	2636.56	2487.88
	(478.70)***	(330.16)*	(151.71)***	(181.37)***
Ethnicity-Race Dummy (White & Not Hispanic=1)	10664.19	8506.32	3216.50	3274.87
	(369.07)***	(241.44)***	(120.53)***	(157.85)***
Age	900.76	674.93	309.96	310.08
	(10.90)***	(7.15)***	(3.63)***	(3.73)***
Work in a Metro Area (1=yes)	5583.12	4464.77	3240.95	3067.08
	(310.53)***	(176.44)***	(98.53)***	(93.86)***
% foreign born with <GED in labor force, state-industry	-234.91	-108.23	-74.32	-98.49
	(27.37)***	(17.62)***	(7.58)***	(12.12)***
Total Value of Shipments	0.0009	0.0014	0.0019	0.0027
	(0.0002)***	(0.0001)***	(0.0001)***	(0.0002)***
Capital/Labor Ratio	0.77	0.97	2.91	4.47
	(0.25)***	(0.30)***	(0.63)***	(0.42)***
Value of Export Shipments	-0.0002	0.0012	0.0017	0.0002
	(0.0005)	(0.0005)**	(0.0004)***	(0.0006)
Computer Share of Investments	-401.32	-230.17	-1791.78	-1360.69
	(447.05)	(184.47)	(259.56)***	(262.65)***
Education Categories	12440.55	10332.21	3466.41	2914.36
	(122.69)***	(78.48)***	(50.56)***	(54.50)***
Import Competition (Complex), WB 'Low' in 1992	28818.64	695.51	-16012.11	-8859.59
	(3,119.38)***	(2440.20)	(1,052.21)***	(1,639.24)***
Observations (rounded to 1000s)	403000	417000	460000	360000
R-squared	0.23	0.23	0.27	0.26
F	487.64	473.68	756.53	546.99
Prob > F	0	0	0	0

Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

NB: Industry, State, and Year fixed effected included in all models

Table 4, Panel B: Routineness and LDC Import Competition - Relationship to Wages - 2SLS Models

	(1)	(2)	(3)	(4)
	Low Routineness	Med-low Routineness	Med-high Routineness	High Routineness
Sex, 1=male	23132.86	15766.06	8726.90	7702.23
	(207.14)***	(144.98)***	(86.95)***	(114.86)***
Nativity, 1=US born	-1956.20	-553.76	2625.75	2489.79
	(479.73)***	(330.86)*	(151.88)***	(181.34)***
Ethnicity-Race Dummy (White & Not Hispanic=1)	10726.90	8515.31	3208.99	3279.31
	(369.45)***	(240.99)***	(120.58)***	(157.73)***
Age	900.93	674.81	310.10	309.96
	(10.91)***	(7.15)***	(3.64)***	(3.73)***
Work in a Metro Area (1=yes)	5506.98	4455.85	3254.77	3058.78
	(311.07)***	(176.33)***	(98.87)***	(93.75)***
% foreign born with <GED in labor force, state-industry	-211.52	-105.90	-75.24	-97.45
	(27.50)***	(17.62)***	(7.61)***	(12.09)***
Total Value of Shipments	0.0009	0.0014	0.0019	0.0027
	(0.0002)***	(0.0001)***	(0.0001)***	(0.0002)***
Capital/Labor Ratio	0.80	0.97	2.90	4.49
	(0.25)***	(0.30)***	(0.63)***	(0.42)***
Value of Export Shipments	-0.0002	0.0012	0.0017	0.0002
	(0.0005)	(0.0005)**	(0.0004)***	(0.0006)
Computer Share of Investments	-414.40	-232.63	-1761.20	-1394.97
	(447.93)	(186.19)	(259.06)***	(264.45)***
Education Categories	12448.60	10330.55	3468.15	2913.86
	(122.83)***	(78.54)***	(50.59)***	(54.48)***
Import Competition (Complex), WB 'Low' in 1992	67197.35	5726.83	-20913.85	-3475.70
	(6,338.14)***	(4325.10)	(2,064.93)***	(4269.15)
Observations (rounded to 1000s)	403000	417000	460000	360000
R-squared	-	-	-	-
F	487.59	473.53	722.91	518.24
Prob > F	0	0	0	0
Kleibergen-Paap rk LM statistic (underidentification)	1.10E+004	5431.962	2961.645	1390.401
Chi-sq(1) P-val	0	0	0	0
Cragg-Donald Wald F statistic (weak identification)	1.50E+005	1.70E+005	1.70E+005	7.20E+004
Kleibergen-Paap rk Wald F statistic	3.70E+004	2.30E+004	1.20E+004	3931.098
Instrument	EU Imports	EU Imports	EU Imports	EU Imports

Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

NB: Industry, State, and Year fixed effected included in all models

Table 5, Panel A: Complexity and LDC Import Competition - Relationship to Wages - OLS Models

	(1) Low Complexity	(2) Med-low Complexity	(3) Med-high Complexity	(4) High Complexity
Sex, 1=male	7763.71 (86.05)***	10035.91 (94.75)***	11017.04 (159.37)***	17505.75 (202.19)***
Nativity, 1=US born	3151.31 (168.17)***	1355.02 (189.73)***	1627.42 (265.22)***	-1536.08 (426.53)***
Ethnicity-Race Dummy (White & Not Hispanic=1)	2800.82 (136.89)***	3886.84 (150.08)***	6143.78 (193.81)***	12503.96 (338.99)***
Age	269.82 (3.56)***	331.13 (4.11)***	477.59 (5.75)***	1066.09 (10.65)***
Work in a Metro Area (1=yes)	2852.99 (98.45)***	3402.39 (100.22)***	4710.11 (139.76)***	5826.49 (274.60)***
% foreign born with <GED in labor force, state-industry	-34.07 (7.76)***	-197.45 (12.82)***	-151.79 (18.03)***	-195.21 (23.99)***
Total Value of Shipments	0.0021 (0.0001)***	0.0018 (0.0001)***	0.0016 (0.0001)***	0.0010 (0.0001)***
Capital/Labor Ratio	0.95 (0.30)***	3.68 (0.70)***	1.02 (0.28)***	0.97 (0.24)***
Value of Export Shipments	0.0009 (0.0005)*	0.0021 (0.0005)***	-0.0002 (0.0004)	0.0001 (0.0004)
Computer Share of Investments	-1177.54 (199.65)***	-1662.36 (312.59)***	-803.36 (372.10)**	-70.09 (84.89)
Education Categories	3181.03 (53.28)***	5489.11 (61.12)***	7501.54 (67.23)***	13522.97 (103.53)***
Import Competition (Complex), WB 'Low' in 1992	-12715.78 (1,258.13)***	12665.44 (1,824.91)***	36730.67 (3,252.53)***	23095.10 (3,064.85)***
Observations (rounded to 1000s)	408000	402000	355000	474000
R-squared	0.2	0.27	0.28	0.2
F	457.1	532.3	463.7	411.45
Prob > F	0	0	0	0

Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

NB: Industry, State, and Year fixed effected included in all models

Table 5, Panel B: Complexity and LDC Import Competition - Relationship to Wages - 2SLS Models

	(1) Low Complexity	(2) Med-low Complexity	(3) Med-high Complexity	(4) High Complexity
	7769.43	9949.12	11044.06	17451.04
Sex, 1=male	(86.06)***	(95.05)***	(160.34)***	(202.86)***
	3126.81	1405.39	1615.98	-1476.43
Nativity, 1=US born	(168.91)***	(189.96)***	(265.91)***	(427.26)***
Ethnicity-Race Dummy (White &	2785.91	3896.12	6169.76	12532.74
Not Hispanic=1)	(136.64)***	(150.38)***	(194.81)***	(338.88)***
	270.00	329.86	476.57	1065.78
Age	(3.56)***	(4.13)***	(5.78)***	(10.65)***
	2875.70	3360.82	4642.97	5781.10
Work in a Metro Area (1=yes)	(98.61)***	(100.66)***	(140.73)***	(274.72)***
% foreign born with <GED in	-36.07	-184.94	-138.72	-180.26
labor force, state-industry	(7.74)***	(13.03)***	(18.31)***	(24.04)***
	0.0021	0.0018	0.0016	0.0010
Total Value of Shipments	(0.0001)***	(0.0001)***	(0.0001)***	(0.0001)***
	0.93	3.80	1.08	0.99
Capital/Labor Ratio	(0.30)***	(0.71)***	(0.29)***	(0.24)***
	0.0009	0.0021	-0.0003	0.0001
Value of Export Shipments	(0.0005)*	(0.0005)***	(0.0004)	(0.0004)
	-1128.77	-1808.35	-940.39	-74.42
Computer Share of Investments	(196.78)***	(314.54)***	(376.61)**	(84.99)
	3182.96	5457.41	7497.72	13511.51
Education Categories	(53.35)***	(60.85)***	(67.44)***	(103.58)***
Import Competition (Complex),	-20428.76	50098.47	76368.20	46070.37
WB 'Low' in 1992	(1,920.76)***	(3,999.21)***	(6,263.46)***	(6,133.06)***
Observations (rounded to 1000s)	408000	402000	355000	474000
R-squared	-	-	-	-
F	450.1	519.94	467.65	411.72
Prob > F	0	0	0	0
Kleibergen-Paap rk LM statistic (underidentification)	2795.646	4792.75	3751.609	9347.055
Chi-sq(1) P-val	0	0	0	0
Cragg-Donald Wald F statistic (weak identification)	2.10E+005	1.10E+005	1.00E+005	1.80E+005
Kleibergen-Paap rk Wald F statistic	1.50E+004	1.40E+004	1.00E+004	3.50E+004
Instrument	EU Imports	EU Imports	EU Imports	EU Imports

Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

NB: Industry, State, and Year fixed effected included in all models

Table 6, Panel A: Interpersonal Interaction and LDC Import Competition - Relationship to Wages - OLS Models

	(1)	(2)	(3)	(4)
	Low Interpersonal Interaction	Med-low Interpersonal Interaction	Med-high Interpersonal Interaction	High Interpersonal Interaction
Sex, 1=male	8869.93	8882.59	14404.56	22785.20
	(102.70)***	(90.81)***	(99.31)***	(278.99)***
Nativity, 1=US born	729.83	2619.68	-1103.08	-5162.38
	(182.30)***	(163.74)***	(211.76)***	(677.92)***
Ethnicity-Race Dummy (White & Not Hispanic=1)	3694.50	2980.97	4969.62	14167.17
	(150.75)***	(133.14)***	(160.74)***	(519.82)***
Age	295.71	325.09	469.44	1171.57
	(3.76)***	(3.86)***	(4.74)***	(14.81)***
Work in a Metro Area (1=yes)	3040.50	3241.46	3699.37	6616.88
	(100.86)***	(100.05)***	(115.99)***	(401.57)***
% foreign born with <GED in labor force, state-industry	-219.17	-123.16	-227.15	-216.14
	(9.86)***	(10.68)***	(11.92)***	(34.87)***
Total Value of Shipments	0.0028	0.0019	0.0016	0.0008
	(0.0002)***	(0.0001)***	(0.0001)***	(0.0002)***
Capital/Labor Ratio	3.15	3.61	0.88	0.94
	(1.25)**	(0.75)***	(0.19)***	(0.33)***
Value of Export Shipments	0.0028	0.0015	0.0002	0.0008
	(0.0008)***	(0.0004)***	(0.0003)	(0.0007)
Computer Share of Investments	-1264.26	-1321.54	-1118.79	-126.20
	(286.43)***	(244.76)***	(253.91)***	(89.23)
Education Categories	5155.49	3991.50	7440.69	14509.85
	(63.14)***	(52.64)***	(52.09)***	(151.09)***
Import Competition (Complex), WB 'Low' in 1992	9057.63	-6744.67	18589.65	20726.19
	(1,520.58)***	(1,844.88)***	(1,869.80)***	(4,361.07)***
Observations (rounded to 1000s)	409000	396000	518000	316000
R-squared	0.29	0.25	0.32	0.18
F	684.9	466.07	789.51	252.8
Prob > F	0	0	0	0

Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

NB: Industry, State, and Year fixed effected included in all models

Table 6, Panel B: Interpersonal Interaction and LDC Import Competition - Relationship to Wages - 2SLS Models

	(1)	(2)	(3)	(4)
	Low Interpersonal Interaction	Med-low Interpersonal Interaction	Med-high Interpersonal Interaction	High Interpersonal Interaction
	8771.12	8882.77	14367.10	22730.88
Sex, 1=male	(102.79)***	(90.91)***	(99.69)***	(279.59)***
	765.47	2568.49	-1057.09	-5093.23
Nativity, 1=US born	(182.48)***	(164.40)***	(211.95)***	(678.78)***
Ethnicity-Race Dummy (White &	3709.54	2953.43	5004.48	14235.86
Not Hispanic=1)	(150.64)***	(133.40)***	(160.92)***	(519.60)***
	294.96	325.75	468.81	1171.93
Age	(3.77)***	(3.86)***	(4.75)***	(14.82)***
	2984.29	3278.10	3663.45	6569.49
Work in a Metro Area (1=yes)	(100.74)***	(100.58)***	(116.15)***	(401.89)***
% foreign born with <GED in	-216.25	-131.19	-217.64	-192.86
labor force, state-industry	(9.87)***	(10.81)***	(12.06)***	(34.87)***
	0.0028	0.0019	0.0016	0.0008
Total Value of Shipments	(0.0002)***	(0.0001)***	(0.0001)***	(0.0002)***
	3.22	3.54	0.90	0.97
Capital/Labor Ratio	(1.28)**	(0.73)***	(0.19)***	(0.33)***
	0.0027	0.0015	0.0002	0.0008
Value of Export Shipments	(0.0008)***	(0.0004)***	(0.0003)	(0.0007)
	-1395.32	-1230.72	-1175.09	-129.79
Computer Share of Investments	(292.29)***	(245.83)***	(255.79)***	(89.53)
	5125.45	3967.26	7432.46	14510.75
Education Categories	(63.01)***	(52.98)***	(52.15)***	(151.13)***
Import Competition (Complex),	29970.42	-29556.98	37775.46	55400.47
WB 'Low' in 1992	(2,630.45)***	(3,551.59)***	(3,508.38)***	(8,443.96)***
Observations (rounded to 1000s)	409000	396000	518000	316000
R-squared	-	-	-	-
F	653.03	470.85	788.36	252.81
Prob > F	0	0	0	0
Kleibergen-Paap rk LM statistic (underidentification)	2618.625	4237.162	6427.929	6984.596
Chi-sq(1) P-val	0	0	0	0
Cragg-Donald Wald F statistic (weak identification)	2.40E+005	5.70E+004	1.90E+005	1.20E+005
Kleibergen-Paap rk Wald F statistic	1.60E+004	7952.675	2.50E+004	2.60E+004
Instrument	EU Imports	EU Imports	EU Imports	EU Imports

Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

NB: Industry, State, and Year fixed effected included in all models

Bibliography

Autor, D. H., F. Levy, and R. J. Murnane. 2003. The Skill Content of Recent Technological Change: An empirical exploration. *Quarterly Journal of Economics* 118 (4):1279-1333.

Baldwin, R. 2006. Globalisation: the great unbundling(s). Finland: Prime Minister's Office, Economic Council of Finland.

Baldwin, R., and F. Robert-Nicoud. 2006. Offshoring and globalisation: What is new about the new paradigm? *Graduate Institute of International Studies, Geneva*.

———. 2010. Trade-in-goods and trade-in-tasks: An Integrating Framework. *National Bureau of Economic Research Working Paper Series* No. 15882.

Baumgarten, D., I. Geishecker, and H. Görg. 2013. Offshoring, tasks, and the skill-wage pattern. *European Economic Review* 61 (0):132-152.

Becker, S. O., K. Ekholm, and M.-A. Muendler. 2013. Offshoring and the onshore composition of tasks and skills. *Journal of International Economics* 90 (1):91-106.

Biscourp, P., and F. Kramarz. 2007. Employment, skill structure and international trade: Firm-level evidence for France. *Journal of International Economics* 72 (1):22-51.

Blinder, A. S. 2006. Offshoring: The Next Industrial Revolution? *Foreign Affairs* 85 (2):113-128.

Blinder, A. S., and A. B. Krueger. 2013. Alternative Measures of Offshorability: A Survey Approach. *Journal of Labor Economics* 31 (2):S97-S128.

Bonacich, E., and J. B. Wilson. 2008. *Getting the goods: Ports, labor, and the logistics revolution*: Cornell University Press.

Bustos, P. 2011. The Impact of Trade Liberalization on Skill Upgrading. Evidence from Argentina. *Economics Working Papers*.

Coe, N. M., M. Hess, H. W.-c. Yeung, P. Dicken, and J. Henderson. 2004. 'Globalizing' regional development: a global production networks perspective. *Transactions of the Institute of British Geographers* 29 (4):468-484.

Dixit, A. K., and G. M. Grossman. 1982. Trade and Protection with Multistage Production. *The Review of Economic Studies* 49 (4):583-594.

Ebenstein, A., A. Harrison, M. McMillan, and S. Phillips. 2013. Estimating the Impact of Trade and Offshoring on American Workers Using the Current Population Surveys. *Review of Economics and Statistics*.

Feenstra, R. C., and G. H. Hanson. 1996. Globalization, Outsourcing, and Wage Inequality. *The American Economic Review* 86 (2):240-245.

Feenstra, R. C., R. E. Lipsey, L. G. Branstetter, C. F. Foley, J. Harrigan, J. B. Jensen, L. Kletzer, C. Mann, P. K. Schott, and G. C. Wright. 2010. Report on the State of Available Data for the Study of International Trade and Foreign Direct Investment. NBER working papers: NBER.

Gereffi, G., and M. Korzeniewicz. 1994. *Commodity Chains and Global Capitalism*: ABC-CLIO.

Goos, M., and A. Manning. 2007. Lousy and Lovely Jobs: The Rising Polarization of Work in Britain. *Review of Economics and Statistics* 89 (1):118-133.

Grossman, G. M., and E. Rossi-Hansberg. 2006. The rise of offshoring: it's not wine for cloth anymore, 59-102.

———. 2008. Trading Tasks: A Simple Theory of Offshoring. *American Economic Review* 98 (5):1978-97.

———. 2012. Task Trade Between Similar Countries. *Econometrica* 80 (2):593-629.

Helpman, E. 1984. A simple theory of international trade with multinational corporations. *The Journal of Political Economy*:451-471.

Hummels, D., R. Jørgensen, J. R. Munch, and C. Xiang. 2011. The Wage Effects of Offshoring: Evidence from Danish Matched Worker-Firm Data. *National Bureau of Economic Research Working Paper Series* No. 17496.

Kemeny, T., and D. Rigby. 2012. Trading away what kind of jobs? Globalization, trade and tasks in the US economy. *Review of World Economics* 148 (1):1-16.

Kohler, W., and J. Wrona. 2011. Offshoring tasks, yet creating jobs? *University of Tübingen working papers in economics and finance* 12.

Krugman, P. R. 1979. Increasing returns, monopolistic competition, and international trade. *Journal of International Economics* 9 (4):469-479.

Leamer, E. E., and M. Storper. 2001. The Economic geography of the Internet Age. *Journal of International Business Studies* 32 (4):641-665.

Levinson, M. 2006. *The Box: How the Shipping Container Made the World Smaller and the World Economy Bigger* Princeton University Press.

Mion, G., and L. Zhu. 2013. Import competition from and offshoring to China: A curse or blessing for firms? *Journal of International Economics* 89 (1):202-215.

Oldenski, L. 2011. The Task Composition of Offshoring by U.S. Multinationals. *Mimeo*.

Rigby, D., T. Kemeny, and A. Cooke. 2014. Import Competition from Low-Wage Countries and Rising Wage Inequality in the United States. Working Paper available from authors.

Robert-Nicoud, F. 2008. Offshoring of routine tasks and (de)industrialisation: Threat or opportunityâ€"And for whom? *Journal of Urban Economics* 63 (2):517-535.

Rojas-Romagosa, H. 2010. *Wage inequality in trade-in-tasks models*: CPB Netherlands Bureau for Economic Policy Analysis.

Spitz-Oener, A. 2006. Technical Change, Job Tasks, and Rising Education Demands: Looking outside the wage structure. *Journal of Labor Economics* 24:235-270.

Chapter 5

Empirical Evidence of the Connection between Import Competition from Low Wage Countries and U.S. Manufacturing Plant Closure

5.1 Introduction

The manufacturing sector in the U.S. has changed substantially over the last half century, shifting what is produced, changing how production is organized, and shrinking relative to other sectors. The previous two chapters have focused on how changes in international trade patterns have affected the wages of manufacturing workers with different characteristics. There have also been substantial changes to the sector at the level of plants as well as at the level of individual workers. This chapter focuses on the trade impacts on plant closure. Specifically, it empirically tests the relationship between low-wage import competition and plant exit, finding that import competition from low-wage countries significantly raises the likelihood of plant closure among U.S. manufacturing establishments.

The empirical tests of the relationship between import competition and plant closure in this chapter build upon previous studies involving this question. The primary contribution of this chapter to the literature is the use of a real panel of establishments, addressing concerns that unobserved establishment characteristics might be driving results in previous studies. This chapter also advances the literature by updating the results to capture trade and plant closure dynamics until just before the Great Recession of 2008, with results spanning 1990 to 2007. This period captures the dramatic rise in import competition from low wage countries, as trade barriers have continued to fall and low-wage countries have rapidly industrialized, focusing much of that industrial development in export-oriented sectors.

The main finding is that increased industry-specific import competition from low-wages countries raises the likelihood of a U.S. manufacturing plant closing down. This finding is robust to several specification strategies and controls for important plant and firm characteristics. These findings also control for unobserved establishment heterogeneity, exploiting a real panel of establishments.

The remainder of the chapter is structured as follows. Section 2 positions this work relative to the literature on trade and plant closure, outlining the theoretical framework guiding the analysis and situating the research in this chapter relative to previous empirical work. Section 3 describes the empirical strategy, including data used, the basic models, and descriptive statistics of the analytical sample. Empirical results from cross-sectional and panel estimates are presented in Sections 4 and 5. A brief conclusion follows.

5.2 Trade and Plant Closure in the Literature

5.2.1 Factor Proportions Framework and Plant Exit

The previous chapters have focused on the implications of the factor proportions framework for groups of workers with different characteristics. Both of these chapters engage with how the increasing fragmentation of production across international borders has led to specialization within industries. Chapter 3 focused on the returns to workers with lower and higher levels of education as key factors of production. Chapter 4 emphasized how increasing fragmentation is focusing specialization at the level of the task and differentially affecting workers with different occupational task specializations. But it is important to remember that the implications of this framework can also apply at the level of the establishment or firm as well as the level of the workers.

As Chapter 2 discussed in more detail, the basic factor proportions insight is that with relatively open trade, countries should specialize in production that reflects their relative factor endowments. The original Heckscher-Ohlin model predicted this specialization would occur at the level of industries. As noted above, the more recent formulations of this basic framework suggest that the specialization will occur within industries. Bernard, Jensen, and Schott (2006) offer a modification of this basic framework that suggests thinking about firms as producing bundles of products, which are reflective of the input intensity of each plant. This is very much the same logic as the original Heckscher-Ohlin framework, where the relative mix of production factors in a country determines specialization across a set of industries. But in Bernard, Jensen, and Schott's work, inputs at the plant level determine the set or bundle of products a plant makes. Thus, low-skill labor intensive plants make products that require the most low-skill labor intensive work within an industry. But these are the products that low-wage countries have a comparative advantage in producing. Therefore, these plants are the most vulnerable to low wage import competition.

Trade liberalization and increasing trade intensity from low-wage countries puts pressure on plants that produce products using low-skill labor intensive techniques. Plants that make a mix of these products and products that require more capital intensity or high-skill labor should shift their specialization away from the low-skill labor intensive products. (This should help drive the wage inequality effects observed in Chapters 3 and 4.) But there are also plants that make bundles of products that largely use low-skill labor intensive methods. These plants are less likely to be able to shift production towards comparatively advantaged products and are more likely to close in the face of increased import competition from low-wage countries. (The workers in these plants were not observed in Chapters 3 as discussed in the conclusion section). This updated, establishment-focused factor proportions approach should lead to increased likelihood of plant closure when import competition from low-wage countries increases.

5.2.2 Empirical Studies of Plant Exit

Though the focus of the present chapter is on the relationship between trade and plant exit, it is worth mentioning closely related questions about plant exit that have received some empirical study. These literatures can be categorized as 1) industry-focused plant entry and exit, 2) exit and multi-national corporation status, and 3) exit and productivity. After reviewing these briefly, I turn my attention to studies of trade and plant exit.

First, there are several studies that focus on industry dynamics and thus define plant entry and exit as entry or exit *from an industry*. This is different from how it is defined in the current chapter, where plant exit is defined more narrowly as plant closure or death. For example, Dunne, Roberts, and Samuelson (1988) used early years of the CMF microdata that is used in the current research, to provide a foundational account of the patterns of manufacturing plant entry, growth, and exit from 1963-1982 in the U.S. by 4-digit SIC industry codes. They track both the birth/death of plants and plants switching their product mix allowing entry into/exit from an industry. They describe basic entry and exit rates and demonstrate that there is substantial variation across industries in these rates. They show that entry and exit patterns across industries are positively correlated over time, so that industries with high entry or exit rates in one period are likely to have similarly high rates later. They also show a positive correlation between entry and exit rates, such that industries with a high entry rate are also likely to have a high exit rate. Finally, they find that there is substantial variation in the entry patterns (and subsequently the exit patterns) of the different types of entries: new firm births, diversifying plants that change industry, and new plants built by a diversifying firm.

In related work (Dunne, Roberts, and Samuelson 1989), these researchers also contribute to understandings of employment turnover, looking specifically at how firms with different characteristics affect employment turnover by their decisions to change their size or close down plants. Part of their research strategy is to understand how plant characteristics relate to plant exit rates. They find that plant characteristics account for a substantial amount of the variation among exit rates. Plant failure is less frequent among older and larger plants. Plant growth rates, when considered jointly with failure rates, differ based on firm structure: whether it is a single- or multi-unit firm.

From this strand of the research that focuses on the industry dynamics – either average plant entry and exit rates or employment turnover within industries – some of the key stylized facts of plant exit emerged: plant size, plant age, single- or multi-unit firm status, and industry all significantly relate to the likelihood of plant exit.

A second strand of the literature on plant exit examines how being part of an MNC might affect the likelihood of a plant exiting (see Benito 2005) for a theoretical investigation of how the international focus of an MNC might affect the likelihood of a subsidiary plant's exit). The definition of plant exit in this line of research is sometimes industry switching, ownership change, or plant death. One example is the work of Alvarez and Görg (2009). They find focus on the link between multinational corporations and plant exit, comparing probabilities of closures between MNC affiliates and domestic plants in Chile's manufacturing sector. They find that the MNC affiliate plants are more likely to exit than domestic plants during a period of economic downturn. They also test whether the presence of an MNC plant affects the likelihood of exit for other plants in the industry. They find that the presence of MNCs appears to lessen the probability of plant closure, but that that effect is entirely accounted for by increased productivity. However their finding does not seem consistent with the findings from other countries. For example, using Portuguese data, Mata and Portugal (2004) find that foreign entrants (either through greenfield entry or acquisition entry) are far less likely to exit than domestically owned firms, in the short- and long-term. There does not appear to be a clear empirical answer to the relationship of foreign-ownership and plant exit at this point. Inui et al. review other similar papers and also conclude that the results vary substantially across different countries (Inui et al. 2009, p. 3). This inconsistency is even evident within the U.S., depending on whether plant characteristics are accounted for. Bernard and Jensen (2007) find that plants owned by U.S. MNCs appear less likely to exit, until plant and industry characteristics are included in the models. Then plants owned by U.S. MNCs are more likely to close. Though the direction of the relationship is context and specification dependent, MNC plants do appear to have different patterns of exit from domestic plants in general (see also, Coucke and Sleuwaegen 2008).

A third strand of the plant exit literature focuses on the relationship between exit and productivity levels. This literature is interested in both the heterogeneity across plants in their productivity and what effect that has on the likelihood of plant exit, as well as the effect of plant exit on average productivity levels in an economy. These studies tend to be more closely related to the focus of the current chapter – trade and plant exit – than the two previous strands of the literature.

In general, these papers find that plants that close have lower productivity. Pavcnic (2002) finds that following trade liberalization by reductions in tariffs in Chile's economy, plants that exit are about 8% less productive than equivalent plants that stay in business. Inui et al. (2009), Bernard et al. (2007), and Coucke and Sleuwaegen (2008) find a similar patterns in Japan, the U.S., and Belgium, respectively.

On the related question of the aggregate effects of plant exit on average productivity levels, the evidence is more mixed. Pavcnic (2002) pays attention to plant exit to account for its role in increasing productivity in aggregate. She finds some evidence of trade liberalization spurring within-firm productivity increases in Chile (1979-1986). However, the stronger aggregate effects appear to be from shifting resources in the economy from less productive plants which exit to more productive plants which remain open. Relatedly, Bernard, Jensen, and Schott (2006)find that within industries, manufacturing activity is generally reallocated towards more capital-intensive plants in the face of low-wage imports. Criscuolo et al. (2004) find a very large contribution from plant entry and exit to productivity growth in the United Kingdom manufacturing sector. They decompose the sources of productivity change by industry, separating the contribution of within firm changes in productivity from the contribution of entry and exit of firms. Interestingly, they find that entry and exit account for a greater share of productivity changes in the 1990s (~50%) than in the 1980s (~25%). Inui et al. (2009), however, find that plant exit by low-productivity firms does not contribute greatly to productivity growth in Japan (1994-2005), largely due to stagnant productivity growth within firms and relative small numbers of plant exits.

I turn now to the literature on trade and plant exit, which focuses variously on the results of trade openness, the relationship to exporting behavior, and the association with import competition, which is most closely related to the research in the current chapter.

Several articles examine the patterns of plant exit following substantial changes in trade openness. This could be a reduction of tariffs that accompany a generalized embrace of trade liberalization, as in Pavcnic's (2002) work on Chile in the late 1970s and early 1980s, which was discussed above. Alternatively, it could be the implementation of a more specific free trade agreement. Gibson and Harris (1996) examine plant exit in New Zealand following trade liberalization in the form of tariff reductions mandated by a trade agreement with Australia. They focus on plant size, plant costs, single- or multi-unit status, and foreign ownership. They find that exiting plants were smaller, higher cost, and owned by diversified firms. For single unit firms, plant costs were more important, but for multi-unit firms, plant size was more important. Another example of a study based on a trade agreement-induced increase in openness is Baggs (2005), who examines Canadian firms following the implementation of the Canada-U.S. Free Trade Agreement in 1989. She examines the results for Canadian manufacturing firms of tariff reductions in Canada, which reduce Canadian survival rates, and tariff reduction rates in the U.S., which increase Canadian survival rates. The net effect of these forces was increased survival rates for two thirds of Canadian firms. She also found that firm characteristics such as scale and leverage reduced some of the negative effects of trade liberalization. Together these papers suggest that policy changes that increase trade openness can greatly affect plant exit patterns, but that those patterns are not entirely straightforward and that individual firm or plant characteristics can mitigate some pressure that might otherwise push a firm to close.

Other articles that focus on trade and plant exit attend to exporting behavior. Alvarez and Görg (2009), discussed previously, investigate the probability of plant closure depending on whether an MNC affiliate exports products internationally or serves the domestic Chilean market. They find that exporting makes a MNC plant less likely to exit than their domestically-oriented counterparts during downturn in the domestic economy. Using data from the UK, Bridges and Guariglia (2008) examine how firm financial characteristics affect firm failure rates. They find that firms with lower collateral and higher leveraging are more likely to survive if they are "globally engaged" rather than just domestically oriented. By "globally engaged" they mean either foreign-owned and/or engaged in exporting. For a subsample of newer firms, the results held when considering foreign ownership and exporting separately. In conjunction with their findings on exit and productivity discussed above, Bernard et al. (2007) connect productivity and exporting behavior. They find that as trade costs fall, higher-productivity firms that are exporting are less likely to fail and firms that do not export and have lower productivity are more likely to exit.

A subset of the broader literature on trade and plant exit is closely related to the research in the current chapter. This deals with import competition or import penetration, as it is sometimes called. Criscuolo et al. (2004), discussed above in relation to productivity, find statistically significant relationships between the rise of net entry rates and import penetration and the information and communications technology (ICT) usage measures. However, when they examine entry and exit independently, exit has no significant association with either import penetration or ICT. Other research, however, finds important relationships between imports and plant exit.

Bernard, Jensen, and Schott (2006) find that when U.S. plants are exposed to higher import penetration from low-wage countries, they are significantly more likely to exit. They also find that in the face of increased low-wage import penetration, plants that do not exit are more likely to shift their product mix, and therefore industry, to industries that are more capital- and skill-intensive and face less import competition from low-wage countries.

Colantone and Sleuwaegen (2010) focus mostly on the impacts of trade openness on firm entry, though they also look at the impacts on firm exit. They use a panel of country-industry pairs, constructed using European data, from 1997-2003 and they construct a measure of trade openness that is somewhat similar to Bernard, Jensen, and Schott's (2006) import penetration measure, with the sum of imports and exports divided by domestic production and imports, all within industries. They find that increased trade openness increases firm exit in the subsequent time period, this relationship is statistically significant, and that this result is largely driven by the import competition mechanisms (rather than the export mechanism channels). This result is consistent with Bernard, Jensen, and Schott's (2006) exit findings. However, in contrast, they also find that there is a negative and statistically significant relationship between exit rates and a measure of intra-industry trade. This means that as industries are characterized by production processes that are more fragmented across countries, exit rates for that industry decrease as trade increases, suggesting that international sourcing can be a survival strategy for firms in trade-intensive industries (p. 1253).

Greenaway, Gullstrand, and Kneller (2008) attend to firm exit from an industry, and like some of the articles discussed at the beginning of this section, they include firms that switch to another industry, firms that are acquired by or merge with another firm, and firm closures. Using data on Swedish firms from 1980 to 1996, they find that increased competition from other countries raises the likelihood of plant closure and of exit from an industry by a merger. The exit portion of this finding is consistent with Bernard, Jensen, and Schott (2006). Consistent with Colantone and Sleuwaegen (2010), they find that this likelihood of exit is lessened when the international trade has a strong intra-industry pattern. Finally, they find that the strength of the trade effect varies when the trade comes from other OECD countries or from other countries. Consistent with the strong low-wage import penetration finding of Bernard, Jensen, and Schott (2006), Greenaway et al. find the probability of firm closure is strongest when the trade is with non-OECD countries. The opposite is true for the probability of a merger or being acquired, which is an interesting departure from the plant closure findings.

Coucke and Sleuwaegen (2008) examine firm exit patterns using data on Belgian manufacturing firms from 1999-2001. They define exit as a closure or as an acquisition by another firm, often a foreign one in their data. They find that import competition from low-wage countries significantly increases the probability of exit, consistent with Bernard, Jensen, and Schott (2006). They also extend the findings by examining other kinds of international interactions, including: effects of MNC-crowding industries (similar effect to import competition on domestic firms); intra-industry trade (similar finding to Greenaway et al. 2008 and Colantone and Sleuwaegen 2010); offshoring to countries outside the E.U. (decreases likelihood of exit); and being owned by an MNC (also decreases likelihood of exit).

The research in the current chapter contributes to this literature in several specific ways. First, it observes exits in more recent years, extending our understanding of these dynamics until just before the Great Recession. This extension not only updates the literature to be more current, but it covers more of the period when imports from low-wage countries expanded dramatically. Second, much of the research on trade and plant exit has used European data. Testing this relationship across different countries is important both for developing a generalized understanding but also for capturing the subtleties in difference across countries, which we should be sensitive to considering the mixed findings from the MNC-plant exit literature. This chapter extends the work done by Bernard, Jensen, and Schott (2006) using U.S. data. Third, this chapter uses a genuine panel of manufacturing plants. This is distinct from the approaches of the recent work of Colantone and Sleuwaegon (2010) that uses a panel of country-industry pairs. It is also distinct from the pseudo-panel used by Bernard, Jensen, and Schott (2006). The real panel form used in the current research should help address concerns about unobserved heterogeneity among plants driving results. Finally, it jointly considers import competition from low-wage countries (following Bernard, Jensen, and Schott 2006) and firm-level characteristics (following Bernard and Jensen 2007) on plant exit. Considering these factors jointly allows for important insights into plant exit.

5.3 Empirical Approach

5.3.1 Sources of Data

Investigating the impacts of trade on the probability of manufacturing plant exit in the U.S. economy requires import and export data along with measures of the characteristics of manufacturing establishments (plant- and firm-level data). As in the previous chapters, non-public microdata from the U.S. Census Bureau are used. Analysis of the impacts of trade from low-wage countries on plant exit is limited to the manufacturing sector of the U.S. economy. In large part this reflects the paucity of data for other parts of the economy.

The Census of Manufactures (CMF) is the basis of the plant and firm-level data used in this chapter. The Longitudinal Business Database (LBD) is used to help link plants between Economic Census years and construct the panel. Exit is identified when a plant in year t is not in existence in year $t+5$. CMF data are utilized for the years 1992, 1997, 2002 and 2007 for this study of manufacturing plant exit. The CMF contains valuable information on plant-level inputs and outputs, including value added, production and non-production employment, capital stocks, overall capital investment and the share of that investment devoted to computers and machinery. The firm-level information on whether the plant is part of a firm with multiple units also comes from the CMF. Firm-level information on whether the firm engages in related-party trade with an affiliate in a low-wage country comes from the import data and is matched to the CMF by employer identification number.

The imports and exports data are used in a similar manner to construct the measure of import competition from low-wage countries. HS codes are translated to NAICS industry codes, rather than the less detailed Census industry codes. This is identical to the LWICOMP measures used in Chapter 3 in the plant-level panels. Plants are assigned a measure of LWICOMP based on their NAICS industry code.

5.3.2 Measures of Trade Competition

To gauge the impact of trade on U.S. labor markets in general and on plant exit in particular requires a measure of trade-based competition. A relatively standard measure of import competition indicates the extent to which imports comprise the overall value of a product available for U.S. domestic consumption. That measure is defined as

$$IMPCOMP_{it} = \frac{IMPORTS_{it}}{SHIPMENTS_{it} - EXPORTS_{it} + IMPORTS_{it}} \qquad (1)$$

where i indexes product type of industry and t indexes the year.

As in the previous chapters, to focus on imports from less-developed or low-wage countries, those that are thought to offer the greatest competition to U.S. workers at the bottom end of the education-skill distribution, the numerator of the import competition measure focuses only on imports from low-wage countries (see equation (2)). This subset of low-wage countries is identified by the World Bank on the basis of GDP per capita data for the year 1992, the first year of analysis. The set of low-wage countries is fixed over the years examined. The World Bank classifies economies into one of four broad groups: low income, lower middle income, upper middle income and high income. Low-wage countries in 1992 were defined as those economies with average annual gross national income below $545. Table 1 lists the 51 countries that comprise this grouping. Note that this group includes relatively large economies that export high volumes of output to the United States such as China and India. Across Latin America and the Caribbean, the only countries that are part of the low income group are Guyana, Haiti and Honduras. This is the same set of low-wage countries and the same measure of import competition used in the previous chapters.

$$LWICOMP_{it} = \frac{LWIMPORTS_{it}}{SHIPMENTS_{it} - EXPORTS_{it} + IMPORTS_{it}} \qquad (2)$$

where $LWIMPORTS_{it}$ represent imports from low-wage economies in industry *i* year *t*.

5.3.3. Descriptive Statistics

U.S. import competition from countries not in the low-wage set increased at a growth rate of 0.33% over the period 1992-2007. Over the same period, import competition from low-wage countries increased at a rate of 4.19%. Of the different groups of countries trading with the United States, it is the low-wage income group that has witnessed the most rapid growth in import penetration over the past two to three decades. Import competition from this group of countries climbed at a relatively steady pace over the study period as a whole. Table 2 reports values of low-wage import competition for individual 3-digit NAICs sectors. In general, relatively low-skill, labor intensive sectors such as textile products, apparel and leather goods production have experienced the highest levels of low-wage import competition, though other industries with significant components of low-skill assembly activities, such as computer and electronics and electrical equipment manufacture as well as furniture production also compete in markets that are contested by low-wage countries. The extent to which imports from these countries are flows of goods from U.S. multi-national corporations, related party firms, is discussed later.

By convention, the analytical samples across which analysis is conducted exclude administrative record plants. These are relatively small, single-plant firms for which considerable data are imputed. The samples also were built following the procedure outlined first in Bernard, Jensen, and Schott (2006) where establishments in sectors where output is listed as "not elsewhere classified" were dropped. This excludes all establishments in NAICS classes that ended in "9". Individual establishments that switched sectors of operation were removed from our sample. Finally, observations were lost in cases where establishments did not report a value for one of the variables listed in our models. Across the four years studied, this resulted in a sample size of approximately 360,000 establishments. Over the three spells between the four census years, approximately 90,000 plants ceased operations and exited the market. Plants in operation in year *t* that were not in operation in any subsequent year through 2007 were defined as exits. Thus, the overall exit rate was approximately 25%. Plants that remained in operation across any two census years are defined as incumbents.

Table 3 displays the characteristics of incumbents and plant exits averaged over the four years for which data are available. In general, incumbent plants are about twice as large as exits, they are about 1.5 years older, they exhibit higher levels of capital investment per worker, they pay higher wages to both production and non-production workers and they face a level of import competition about 9 percentage points lower than exiting plants. Incumbent plants tend to export more than exits, they are more likely to be a part of a multi-unit firm and they are more likely to be part of a multi-national firm that engages in related part trade with a country in the low-wage country group.

5.4 Analysis and Results: Models of Plant Exit

5.4.1 Cross-sectional Model

The models of exit developed in this section are driven by the differences in establishment characteristics reported in Table 3. From the models linking plant exit to import competition developed by Bernard, Jensen, and Schott (2006), by Coucke and Sleuwaegen (2008), and Colantone et al. (2013), and the more general models of plant and firm exit (Dunne, Roberts, and Samuelson 1989; Siegfried and Evans 1994; Baldwin and Gorecki 1998) I develop a composite econometric specification of manufacturing plant exit as:

$$Exit_{pt+5} = \alpha + \boldsymbol{\beta}'_k \boldsymbol{C}_{kpt} + \boldsymbol{\beta}'_l \boldsymbol{F}_{lpt} + \beta_m LWICOMP_{it} + \delta_i + \delta_r + \delta_t. \qquad (3)$$

where ***C*** is a *k*-element vector of characteristics for plant *p* at time *t*, ***F*** is an *l*-element vector of firm characteristics for plant *p* at time *t*, *LWICOMP* measures import competition from low-wage economies specific to the industry and year, and the δ terms capture industry, state and time fixed effects. α , β_m and the vectors $\boldsymbol{\beta}_k$ and $\boldsymbol{\beta}_l$ represent parameters to be estimated.

In equation (3), the dependent variable is binary and indicates whether or not a plant is in operation at time period *t+5*. The independent plant-level that contribute to ***C*** include the value of shipments, the capital-labor ratio, the value of plant exports, plant age and the share of capital investment spent on computing equipment. The firm-level characteristics that contribute to ***F*** include whether or not the plant is part of a multi-unit firm and whether or not the plant belongs to a firm that engages in related-party trade in a low-wage country. All these independent variables are measured at time *t*. Note also that I use two consecutive periods to define exit and thus have three waves over the years 1992-1997, 1997-2002 and 2002-2007. These waves are pooled and the time fixed effect captures common shocks between periods. Equation (3) is estimated both as a logistic regression and in the form of a linear probability model. All the standard errors reported are robust to heteroscedasticity. This is critical for the linear probability model introduces heteroscedasticity into the relationships estimated (Greene 2003).

5.4.2 Results of Cross-sectional Estimations

Table 4 contains the results of modeling plant exit, estimating equation (3) using a logistic regression then a linear probability model (LPM). The logit model (column 1) contains only plant-level characteristics. I then switch from the logit specification to the LMP model because singularity issues in the logit specification prevented separation of the effects of multi-unit firm membership and membership in firms that engage in related-party trade in low-wage countries. The LPM models repeat the initial plant characteristics estimation (column 2) then add in firm-level characteristics (column 3). The last column (4) reports a robustness check by excluding the wave where *t*=1997, to test whether the imputed values for computer share of investment in 1997 alter the results (this is discussed in Chapter 3). This model includes firm-level characteristics.

First I consider the plant-level characteristics across the four estimations presented in Table 4. However, several of the basic plant characteristics operate similarly across the models. For example, consistent with prior theory, larger plants, older plants, and plants that are more capital-intensive are less likely to exit. The results for computer share of investment are somewhat more mixed. In all of the models the coefficient is negative indicating that the probability of plant exit is lower as computer share of investment increases. However, this relationship is only statistically significant in the logit model (Column 1). Exports have a similarly mixed result across these models. In the logit, the coefficient on exports is negative but not statistically significant while the opposite is true in the LMP models. In these models (Columns 2-4), higher levels of exports from a plant significantly raise the probability of exit. This result is a bit surprising, but I return to this later when I present the panel models.

Next I consider the firm-level characteristics included in Columns 3 and 4. If a plant is part of a multi-unit firm, that significantly lowers the probability of exit. Similarly, if a plant is part of a firm that engages in related-party trade originating in a low-wage country, that also significantly lowers the probability of exit. This is a characteristic not included in the Bernard, Jensen, and Schott (2006) work that focuses solely on plant-characteristics and is distinct from the findings of Bernard and Jensen (2007) in its focus on the relationship to low-wage countries. Bernard and Jensen (2007) find that being part of a MNC raises the likelihood of exit. However, their focus is on MNC status where the location of foreign affiliates could be in any country. I focus on a more specific relationship, where the plant must be part of an MNC and must trade with a foreign affiliate located in a low-wage country. This is a potentially important distinction. The Bernard and Jensen work suggests that plants in MNCs are more likely to be closed in general. However, my results suggest that plants which are part of MNCs engaging in what we might typically think of as offshoring to low-wage countries are undertaking some form of triage within plants rather than across plants. By this I mean that these MNCs are likely preserving plant operations overall but shedding specific types of tasks within each plant. This is consistent with the important product-switching findings of Bernard, Jensen, and Schott (2006). It is also consistent with the findings of Coucke and Sleuwaegon (2008) that offshoring to non-European Union countries can operate as a survival strategy among Belgian firms.

The key result in Table 4 is on the low-wage import competition variable (LWICOMP). For this characteristic, the results are notably consistent across all four models. LWICOMP significantly raises the probability of plant exit. Thus, plants in industries facing a lot of competition from imports originating in low-wage countries are more likely to close. This is consistent with the findings of Bernard, Jensen, and Schott (2006).

Also of note in Table 4 is the similarity of the estimates in Columns 3 and 4. Column 3 includes plant and firm characteristics and uses data from all three waves of years. Column 4 presents the same characteristics, but excludes the wave that starts in year 1997 (t=1997). Because information on computer expenditures was not collected in the 1997 Census of Manufactures, I imputed the 1997 measures of computer share of investment (described in more detail Chapter 3). Excluding the 1997 wave from these results tests whether the imputation is significantly altering results. The similarity between the estimates in these two columns gives some assurance that this is not the case.

The results derived from linear probability models (Columns 2-4) should be interpreted with some caution. In cross sectional form, the linear probability model introduces heteroscedasticity. However, the linear probability model does not bias estimators (Greene 2003). While there is considerable disagreement in the literature on the appropriateness of using the linear probability model (LPM) in cross-sectional models, in panel form using the LPM is much less a concern (Wooldridge 2010). The switch to panel models is encouraged by the desire to control for unobserved heterogeneity in equation (3). Using the LPM in the panel context is not something I could avoid given that the fixed effects panel variant of the logit model would not converge. I turn now to the panel estimates.

5.4.3 Panel Model

Many models of plant exit are cross-sectional in form, taking plant, firm, and industry characteristics in time period t and relating those to the probability of plant exit in the time step between time period t and $t+1$ (or $t+5$ in our case). While this specification is common, it does not take full advantage of the possibilities in the data, particularly those that control for unobserved heterogeneity at the plant level. An example of a missing variable that might have serious impacts on a cross-sectional model of exit is managerial expertise. Unfortunately, no information about the skills of managers is available, but it is clear that managerial expertise is likely to impact a number of the variables on the right-hand side of equation (3) that reflect choices of business owners/managers. This correlation, unless controlled, violates a key assumption of exogeneity in the regression model. The problem of unobserved heterogeneity is tackled using a fixed effects panel model. Unfortunately, the conditional logit model in panel form would not converge and this required a switch to the linear probability model in panel form for estimation. As discussed above, the limitations of LMP appear to be reduced when using a panel form.

The panel model of exit requires three consecutive time periods to estimate. Rather than explore the relationship between plant characteristics at time period *t* and the probability of exit between time *t* and *t+5*, analysis in panel mode shifts to account for the probability of plant exit over the period *t+5* to *t+10*, using changes in plant characteristics taken from periods *t* and *t+5*. The four years of plant data thus provide two waves in the panel model, the first covering the period 1992-2002 inclusive and the second covering the period 1997-2007 inclusive. Each wave of the panel takes the following form

$$\Delta Exit_{pt+5\to t+10} = \boldsymbol{\beta}'_k \boldsymbol{\Delta C}_{kpt\to t+5} + \boldsymbol{\beta}'_l \Delta \boldsymbol{F}_{lpt\to t+5} + \beta_m \boldsymbol{\Delta} LWICOMP_{it\to t+5} + \delta_t \quad (4)$$

where the $\boldsymbol{\Delta}$ operator signifies the one period difference in the variable or vector of variables that follow; ***C*** is a *k*-element vector of characteristics for plant *p* at time *t*, ***F*** is an *l*-element vector of firm characteristics for plant *p* at time *t*, *LWICOMP* measures import competition from low-wage economies specific to the industry and year, and the δ term is a fixed effect capturing common shocks from one wave of the panel to the next. Note that the industry and region fixed effects drop out of this panel form.

Results from estimating equation (4) are reported in Table 5. Note that manufacturing plants in the first wave of the panel that remain in production through at least 2002 are present in both waves of the panel. In a second sample for equation (4) plants present in both waves of the panel were removed to ensure the independence of all observations and the results re-estimated. The results were qualitatively similar in both variants of equation (4) and so only the first set is reported here.

The variables used in this model are nearly identical to those used in the previous models. One difference is the plant age variable. Because this is a panel set up, a straightforward measure of plant age would drop out of the model since all plants are aging at the same rate. However, the difference between surviving from one period to the next for a plant that is only a year old and for a plant that is a decade old is not the same and I can exploit this difference to capture the aging effect of plants on the probability of exit by measuring changes in relative plant age over time. The relative age of a plant is calculated by dividing the year *t* by the year of birth of the plant. Thus, in the year 2005 a plant born in 1950 has the relative age 2005/1950 = 1.028205. A plant born in 2000 has a relative age in 2005 equal to 2005/2000 = 1.0025. By 2010, the relative age of the plant born in 1950 has increased to 1.030769 and the relative age of the plant born in 2000 has increased to 1.005. Over the 5-year period between 2005 and 2010, the plant born in 1950 has aged in relative terms by 1.030769-1.028205=0.002564 years. Over the same period, the plant born in 2000 has aged by 1.005-1.0025=0.0025 years. The older plant has aged faster in relative terms. We would anticipate a negative effect of aging in our exit models. Those plants that age faster (older plants) should have a lower probability of exiting than younger plants. This is indeed what we see in the results.

5.4.4 Results of Panel Model Estimations

Table 5 displays the results of modeling plant exit, estimating equation (4) using a linear probability model (LPM) in Columns 1 and 2. Column 1 controls only for plant-level characteristics. Column 2 adds in the firm-level characteristics. The standard plant-level characteristics operate much as expected and are consistent across the two models. The size of the plant (total value of shipments) and the relative age of the plant are both negatively associated with plant exit. These relationships are statistically significant. In a slight departure from the theoretical priors, the capital intensity (capital-labor ratio) has a positive relationship to plant exit, but is not statistically significant. Exports appear to operate as expected, lowering the likelihood of exit. However, the relationship is not statistically significant. This is a departure from the cross sectional models described above, where the coefficient on exports was positive and significant, perhaps due to the issues with LPM in cross sectional form. The final plant-level characteristic is the computer share of investment, which significant lowers the probability of exit. This is in line with expectations.

Column 2 includes the two firm-level variables. First, being part of a multi-unit firm significantly increases the likelihood of exit in this model. This is the opposite of the findings in the cross sectional models. It is also inconsistent with the findings of Bernard and Jensen (2007), however, they do not include import competition in their models, so the results are not directly comparable. Second, being part of a firm that engages in related-party trade with a foreign affiliate in a low-wage country significantly lowers the probability of exit. This is consistent with the cross-sectional model results. As discussed above, this is consistent with related findings of product switching in the face of low-wage import competition (Bernard, Jensen, and Schott 2006) as well as findings on offshoring as a survival strategy (Coucke and Sleuwaegon 2008).

The key result for this research is the relationship between low-wage import competition and plant exit. In both Columns 1 and 2, LWICOMP raises the probability of exit and this is statistically significant. This is consistent with theoretical priors.

Concerns remain about endogeneity with the models as estimated in Column 1 and 2. It is possible that increased U.S. imports are themselves the result of prior decisions by U.S. manufacturers to engage in offshoring, substituting foreign production for domestic operations. This case raises the possibility of simultaneity bias in the regression models, generating one form of endogeneity. As in the previous chapters, I employ an instrumental variable approach using a measure of low-wage imports for the EU15 countries of Europe, from the same low-wage countries used in the U.S. import competition measure. This measure of European imports is constructed for the same industry groups and time periods as the plant data. It is reasonable to assume that this variable is not impacted by the competitive adjustments of U.S. producers and simple statistical tests show that this variable is reasonably well-correlated with low-wage import competition across U.S. manufacturing sectors.

The instrumental variable model is estimated with a generalized method of moments (GMM) estimator, which is useful for its efficiency (see Baum et al. 2007). The results are show in Table 5, Columns 3 and 4. Column 3 reports results controlling for plant-level characteristics (like Column 1). Column 4 reports results controlling for addition firm-level characteristics (like Column 2). The the first stage diagnostics reported at the bottom of the table indicate the suitability of the instrument. The Kleibergen-Paap (K-P) rk LM Chi-squared/p-value statistics indicate that the instrumented model passes this underidentification test. The Kleibergen-Paap (K-P) F-statistic reports on the instrument relevance, and with a value well above the Stock-Yogo critical values, I conclude that the instrument is relevant and not weak. Unfortunately with only one instrument, I cannot report statistics relevant to overidentification (e.g., Hanson's J). The results are remarkably similar to the non-instrumented models, leading me to conclude that endogeneity of LWICOMP is not greatly biasing the results.

A word of caution about these results. Though the panel models address concerns about unobserved heterogeneity among plants, the three time-period requirement does bias the sample towards plants that have already survived for a long time, particularly since the Census years are five years apart. The construction of this panel necessitates eliminating many plants that exit within the first few years of existence, a substantial percentage of firms (see, Haltiwanger, Jarmin, and Miranda 2013). Some caution in how far these results can be generalized, even for the U.S., is needed.

5.5 Conclusion

Patterns of world trade have changed substantially over the past decades, with substantial growth in imports from low-wage countries in to the U.S. and other high-wage countries. This is visible in daily life by inspecting the "Made In" tags on any number of household items. Evidence of the effect of this shift in import competition on workers was examined in the previous two chapters. The effect on plant exit is the focus of this chapter.

Evidence on the relationship between globalization and plant exit is building and this chapter contributes to an updated understanding of this relationship in the U.S.

Specifically, this chapter examines the relationship between low-wage import competition and plant exit among U.S. manufacturing plants. It uses a genuine panel of plants and controls for both plant-level and firm-level characteristics. It finds that high levels of import competition from low-wage countries significantly increases the likelihood of plant exit. This finding is consistent across several specifications and robustness tests. This finding is consistent with previous studies, but adds to the literature by in several ways. This is the first true panel of plant exit in the U.S. I am aware of that focuses on the impacts of import competition. It extends the important findings of Bernard, Jensen, and Schott (2006) through updating the time period, adding independent variables at the firm-level, and controlling for unobserved heterogeneity among plants. It also confirms their basic finding using other instrumental variables, building support their factor-proportions explanation of the effects of increased trade with low-wage countries. This framework predicts that plants specialized in low-skill labor intensive production will be most vulnerable to competition from low-wage countries. Plants operating in industries that face very high import competition from low-wage countries should be more likely to close down. The findings in this chapter clearly support this picture.

Table 1: Low-Wage Countries used in the Import Competition Measures

Afghanistan	Comoros	Haiti	Maldives	Sao Tome
Bangladesh	Congo	Honduras	Mali	Sierra Leone
Bhutan	Eqypt	India	Mauritania	Solomon Isl.
Benin	Equatorial Guinea	Indonesia	Mozambique	Somalia
Burkina Faso	Ethiopia	Kenya	Myanmar	Sri Lanka
Burundi	Gambia	Laos	Nepal	Sudan
Cambodia	Ghana	Lesotho	Niger	Tanzania
Central African Rep.	Guinea	Liberia	Nigeria	Togo
Chad	Guinea-Bissau	Madagascar	Pakistan	Uganda
China	Guyana	Malawi	Rwanda	Vietnam
				Zambia

NB: Classified according to the World Bank, using year 1992.

Table 2: Low-Wage Country Import Competition

NAICS	Manufacturing Industry	Low-Wage Import Competition 1992	1997	2002	2007
311	Food	0.4	0.5	0.5	1.1
312	Beverage & Tobacco	0	0.2	0.2	0.2
313	Textile Mills	3.2	3.5	5.2	8.5
314	Textile Products	8.6	7.7	14.1	32.8
315	Apparel	16.4	21	28.2	57.5
316	Leather	28.2	42.3	58.4	70.3
321	Wood	1.7	1.6	2.1	3.8
322	Paper	0.2	0.4	0.9	2.1
323	Printing & Related	2.2	1.7	5.3	14.2
324	Petroleum & Coal	0.4	1.3	0.8	0.6
325	Chemicals	0.4	0.7	0.9	1.8
326	Plastics & Rubber	0.8	1.6	2.8	6.1
327	Non-Metallic Minerals	1.4	2.6	4.5	6.3
331	Primary Metals	0.6	0.8	1.4	3.8
332	Fabricated Metals	1.1	1.6	3.5	6.9
333	Machinery	0.6	1.4	2.8	6.4
334	Computer & Elec	2.1	3.6	9.3	23.1
335	Electrical Equipment	2.9	5.3	10.1	16.5
336	Transport Equipment	0.1	0.2	0.5	1.7
337	Furniture	1.5	4	11.1	19.9
339	Micellaneous	10.5	14.4	17.7	26
	Mean	4	6	9	15
	Standard Deviation	7	10	13	19

NB: Low-Wage Import Competition measures are shown as percentages.

Table 3: Characteristics of Manufacturing Plants that Exit and Incumbents (all years)

VARIABLE	INCUMBENTS	EXITS	T-STATISTIC	P-VALUE
TVS	19018.94	10029.6	23.246	0.000
	(264.947)	(281.681)		
KL	63.49	58.765	3.700	0.000
	(0.390)	(1.216)		
AGE	14.391	12.746	50.292	0.000
	(0.015)	(0.029)		
EXPORTS	1582.569	664.368	10.975	0.000
	(74.686)	(41.594)		
MULTI	0.303	0.261	24.504	0.000
	(0.001)	(0.001)		
MNC-LWC	0.010	0.008	8.057	0.000
	(0.002)	(0.003)		
COMPSHR	0.075	0.076	-0.716	0.218
	(0.001)	(0.000)		
LWICOMP	0.016	0.025	-36.086	0.000
	(0.000)	(0.000)		
NPWSHARE	0.378	0.371	9.066	0.000
	(0.000)	(0.001)		
AVEWP	27.044	26.782	4.857	0.000
	(0.024)	(0.048)		
AVEWNP	46.273	43.109	22.821	0.000
	(0.066)	(0.122)		

NB: The number of observations for incumbent plants was 274000 and the number of observations for exiting plants was 90000. The terms in parentheses represent standard errors. The t-statistic was obtained through a two-sample means test. All values refer to means for the two plant types. TVS is the total value of shipments, KL is the capital-labor ratio, AGE is the number of years since plant establishment, exports represent plant level direct exports, multi refers to the share of plants that belong to a multi-unit firm, MNC-LWC denotes the share of plants that are part of multi-national firms that have foreign affiliates in a low-wage country, COMPSHR represents the share of investments devoted to computers and related equipment, LWICOMP is the measure of low-wage country import competition for the industry in which the plant is located, NPWSHARE is the non-production wage share, AVEWP is the average annual wage of production workers (in $000), AVEWNP is the average annual wage of non-production workers (in $000).

Table 4: Low-Wage Import Competition and Plant Exit: Cross-Sectional Estimations

	(1)	(2)	(3)	(4)
	all years	**all years**	**all years**	**t=1997 dropped**
	Logit	**LPM**	**LPM**	**LPM**
Total Value of Shipments	-2.70e-06***	-1.30e-07***	-1.12e-07***	-1.08e-07***
	(4.12e-07)	(1.04e-08)	(9.51e-09)	(9.84e-09)
Capital-Labor Ratio	-.00016*	-.00002*	-.00002*	-.00003***
	(.00009)	(.00001)	(9.40e-06)	(.00010)
Exports	-5.71e-07	9.32e-08***	8.26e-08***	7.16e-08***
	(1.41e-06)	(2.93e-08)	(2.53e-08)	(2.70e-08)
Plant Age	-.03291***	-.00653***	-.00641***	-.00711***
	(.00053)	(.00010)	(.00010)	(.00011)
Multi-Unit Dummy			-.02510***	-.03327***
			(.00175)	(.00190)
Low-Wage Country Related-Party Trade Dummy			-.06311***	-.02309***
			(.00652)	(.00746)
Computer Share of Investments	-1.02774***	-.01157	-.01135	-.00317
	(.03334)	(.01036)	(.01020)	(.00278)
LWICOMP	.53022***	.27025***	.27546***	.31432***
	(.188835)	(.03303)	(.03305)	(.03325)
Observations (rounded)	364000	364000	364000	287000
R-squared	.0942 (pseudo)	.0962	.09670	.1131
Wald Chi-squared	31465.12			
Prob>Chi-squared	0			
LL(0)	-203284.04			
LL(F)	-184127.57			

Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

NB: Industry, State, and Year fixed effected included in all models

NAICS 9 "not elsewhere classified" dropped from sample

Table 5: Low-Wage Import Competition and Plant Exit: Panel Estimations

	(1) LPM	(2) LPM	(3) 2SLS	(4) 2SLS
Total Value of Shipments	-1.55e-07***	-1.56e-07***	-1.21e-07***	-1.21e-07***
	(2.72e-08)	(2.69e-08)	(2.87e-08)	(2.81e-08)
Capital-Labor Ratio	1.03e-06	1.06e-06	2.01e-06	2.13e-06
	(5.35e-06)	(5.33e-06)	(7.85e-08)	(7.84e-06)
Exports	-3.55e-08	-2.70e-08	-3.71e-08	-2.47e-08
	(5.53e-08)	(5.43e-08)	(4.83e-08)	(4.63e-08)
Relative Plant Age	-2988.746***	-2976.025***	-2236.552***	-2217.837***
	(152.3146)	(152.377)	(201.9505)	(202.0759)
Multi-Unit Dummy		.01503**		.01627*
		(.00737)		(.00880)
Low-Wage Country Related-Party Trade Dummy		-.04915***		-.06765***
		(.00930)		(.01066)
Computer Share of Investments	-.22405***	-.22424***	-.21500***	-.21529***
	(.00820)	(.00820)	(.01033)	(.01034)
LWICOMP	.35692***	.36037***	3.5862***	3.59819***
	(.04765)	(.04764)	(.20975)	(.20994)
Observations (rounded)	365000	365000	365000	365000
R-squared	.2718	.2719		
F			158.59	122.78
Prob > F			0.000	0.000
Kleibergen-Paap rk LM statistic (under id)			2101.446	2099.953
Chi-sq(1) P-val			0.000	0.000
Cragg-Donald Wald F statistic (weak id)			5946.878	5935.126
Kleibergen-Paap rk Wald F statistic			1941.352	1939.899
Instrument			EU Imports	EU Imports

Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

NB: Industry, State, and Year fixed effected included in all models

NAICS 9 "not elsewhere classified" dropped from sample

Bibliography

Alvarez, R., and H. Görg. 2009. Multinationals and plant exit: Evidence from Chile. *International Review of Economics & Finance* 18 (1):45-51.

Baggs, J. 2005. Firm survival and exit in response to trade liberalization. *Canadian Journal of Economics/Revue canadienne d'économique* 38 (4):1364-1383.

Baldwin, J. R., and P. Gorecki. 1998. *The dynamics of industrial competition: A North American perspective*: Cambridge University Press.Benito, G. R. G. 2005. Divestment and international business strategy. *Journal of Economic Geography* 5 (2):235-251.

Baum, C. F., M. E. Schaffer, and S. Stillman. 2007 Enhanced routines for instrumental variables/GMM estimation and testing. *Stata Journal* 7(4): 465-506.

Bernard, A. B., and J. B. Jensen. 2007. Firm Structure, Multinationals, and Manufacturing Plant Deaths. *Review of Economics and Statistics* 89 (2):193-204.

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. 2006. Survival of the best fit: Exposure to low-wage countries and the (uneven) growth of U.S. manufacturing plants. *Journal of International Economics* 68 (1):219-237.

Bridges, S., and A. Guariglia. 2008. Financial Constraints, Global Engagement, and Firm Survival in the United Kingdom: Evidence from Micro Data. *Scottish Journal of Political Economy* 55 (4):444-464.

Colantone, I., and L. Sleuwaegen. 2010. International trade, exit and entry: A cross-country and industry analysis. *Journal of International Business Studies* 41 (7):1240-1257.

Coucke, K., and L. Sleuwaegen. 2008. Offshoring as a survival strategy: evidence from manufacturing firms in Belgium. *J Int Bus Stud* 39 (8):1261-1277.

Criscuolo, C., J. Haskel, and R. Martin. 2004. Import Competition, Productivity, and Restructuring in UK Manufacturing. *Oxford Review of Economic Policy* 20 (3):393-408.

Dunne, T., M. J. Roberts, and L. Samuelson. 1988. Patterns of firm entry and exit in US manufacturing industries. *The RAND Journal of Economics*:495-515.

———. 1989. The growth and failure of US manufacturing plants. *The Quarterly Journal of Economics* 104 (4):671-698.

Gibson, J. K., and R. I. D. Harris. 1996. Trade liberalisation and plant exit in New Zealand manufacturing. *The Review of Economics and Statistics*:521-529.

Greenaway, D., J. Gullstrand, and R. Kneller. 2008. Surviving globalisation. *Journal of International Economics* 74 (2):264-277.

Greene, W. H. (2003). *Econometric Analysis,* 5th. Ed. Upper Saddle River, NJ.

Haltiwanger, J., R. S. Jarmin, and J. Miranda. 2013. Who Creates Jobs? Small versus Large versus Young. *Review of Economics and Statistics* 95 (2):347-361.

Inui, T., R. Kneller, T. Matsuura, and D. McGowan. 2009. Globalization, Productivity and Plant Exit: Evidence from Japan. *RIETI Discussion Paper Series* 09-E-048.

Mata, J., and P. Portugal. 2004. Patterns of Entry, Post-Entry Growth and Survival: A Comparison Between Domestic and Foreign Owned Firms. *Small Business Economics* 22 (3-4):283-298.

Pavcnik, N. 2002. Trade Liberalization, Exit, and Productivity Improvements: Evidence from Chilean Plants. *The Review of Economic Studies* 69 (1):245-276.

Siegfried, J. J., and L. B. Evans. 1994. Empirical studies of entry and exit: a survey of the evidence. *Review of Industrial Organization* 9 (2):121-155.

Wooldridge, J. M. 2010. *Econometric analysis of cross section and panel data*. MIT press.

Chapter 6

Conclusion

6.1 Introduction

International trade flows have shifted substantially over the past few decades, with exports from low-wage countries, such as China, storming onto the world market. This has changed the composition of import flows into the U.S., altering the competitive environment that American manufacturers face. This dissertation examines some of the key impacts of this new competitive environment, analyzing the consequences for wage inequality (including its variation across different regions and how it is mediated by task characteristics) as well as the effects on the likelihood of plant exit.

The aim of this chapter is two fold. First it provides a brief overview of the three analytical chapters, summarizing the main contributions and findings of this dissertation. Second, it juxtaposes the findings of the three chapters to lend some context to the inequality findings.

6.2 Inequality Findings in Chapter 3

Chapter 3 employs an updated factor proportions theoretical framework and uses matched employer-employee microdata and establishment panels covering the period 1990-2007, when imports from low-wage countries were growing rapidly. The goal of the analysis is to consider the impact of industry-specific low-wage import competition on the wages of manufacturing workers in different skill groups, here differentiated by level of formal education (in the matched employer-employee models) and the relative wages of nonproduction and production workers (in the establishment panel models). Controls for individual and establishment characteristics that affect wages are in the model, including establishment-specific computer investments, a measure that captures skill-biased technological change.

The primary finding is that low-wage import competition significantly affects wages, and does so differently for workers with different levels of education. Controlling for individual demographic and establishment characteristics, higher low-wage import competition lowers the wages of low-education workers and raises wages of high-education workers nationally. Low-wage import competition also increases the nonproduction worker share of total payroll, which is interpreted in the literature as an increase in inequality. Underlying the national story, this chapter reveals that there is substantial regional variation in the relationship between import competition and wages.

These findings strongly support the current theoretical predictions that imports from low-wage countries should increase wage inequality in advanced economies like the U.S. Compatible with other recent findings based on different data and specifications (e.g., Autor, Dorn, and Hanson 2012), the results presented here bolster a picture of increasing national inequality associated with trade and regional variation in those impacts. This suggests that perhaps there is a new consensus emerging on trade and inequality in the current period, a consensus that reflects both generalized theoretical frameworks and is sensitive to how the regional context of trade and labor markets shape the actually existing wages of workers.

6.3 Task Trade Findings in Chapter 4

Chapter 4 examines the effects of trade on workers' wages not by broad skill groups measured by education or production/nonproduction status, but based on the intensity of key task characteristics in occupations. The importance of observing task characteristics comes from increasingly fine fragmentation in production processes and new patterns of specialization across international borders via trade. This fragmentation and consequent specialization are now occurring at the level of the task. Recognition of trade in tasks complicates the predictions about which workers will be affected by trade and suggests new characteristics that distinguish workers vulnerable to trade competition: the level of routineness, complexity, and interpersonal interaction in their occupation.

This chapter asks how different task intensities mediate the relationship between low-wage import competition and wages of U.S. manufacturing workers. It finds that low-wage import competition is associated with lower wages for workers with highly routine jobs and workers with low complexity intensity jobs. It also finds that workers in jobs with low routineness and those with high complexity earn higher wages when there is greater low-wage import competition. The relationship associated with interpersonal interaction is less straightforward. Workers with the lowest and highest levels of interpersonal interaction in their occupations receive higher wages in the face of higher import competition, but workers with medium-low intensity of this characteristic have lower wages with greater import competition.

In general, these findings support theoretical predictions that workers who perform tasks that are more vulnerable to task trade also face negative wage effects associated with low-wage import competition. These results also show that the effects of trade are not linear, with the import competition effect dependent on the task intensity. At least for routineness and complexity (it is a little less clear what is happening with interpersonal interaction), it appears that the proportion of workers affected negatively or positively is skewed. Only the lowest quartile of workers based on complexity suffer lower wages, but half of workers with more routine jobs have significantly lower wages. Only the lowest quartile of workers based on routineness has benefited from higher wages, but three-quarters of the workers grouped by complexity have higher wages in the face of increased import competition. The size of the group of workers who are potentially affected by import competition based on a particular task characteristic varies.

6.4 Plant Exit Findings in Chapter 5

Chapter 5 examines the relationship between low-wage import competition and plant exit among U.S. manufacturing plants. It uses a real panel of plants and controls for both plant-level and firm-level characteristics. It finds that high levels of import competition from low-wage countries significantly increase the likelihood of plant exit. It extends the important findings of Bernard, Jensen, and Schott (2006) through updating the time period, adding independent variables at the firm-level, and controlling for unobserved heterogeneity among plants. It also confirms their basic finding using other instrumental variables, building support for their factor-proportions explanation of the effects of increased trade with low-wage countries. This provides additional evidence that plants specialized in low-skill labor intensive production are the most vulnerable to low-wage import competition and plants in industries facing high import competition from low-wage countries are more likely to close.

6.5 Reading these Findings Together

The theoretical trade models largely rest on assumptions about full employment conditions and the frictionless reallocation of labor across industries.[24] But there are other effects possible from trade including job loss that are not explicitly modeled and have implications for how we understand the effects of trade more broadly. This section considers the findings in Chapter 3 in relation to the other chapters, sketching out some of the limits of these findings and the implications for how we understand them.

The findings in Chapter 3 likely do not reflect the full extent of the effect of low-wage import competition on wages, particularly for those with less education or in task trade-vulnerable occupations. The analytical sample of workers includes only those with positive wages in manufacturing and it is further limited to full-time, full-year workers, who presumably have greater wage protections and bargaining leverage than part-time workers. Furthermore, the sample reflects workers in sector with a dramatically shrinking labor force. Many workers in the U.S. have left the manufacturing sector over the past several decades, finding work in other sectors, leaving the workforce, or they are unemployed. Likewise, the sample only includes establishments that have positive employment and shipments. It does not observe plants that close, putting people out of work and potentially increasing pressure on other local establishments or sectors to absorb this labor. We know, however, from Chapter 5 that plants in industries facing high levels of low-wage import competition have a higher likelihood of closing.

[24] A notable exception to this rule relaxes full employment assumptions and explicitly models unemployment (Kohler and Wrona 2011).

Related work done with Kemeny and Rigby (2013) using an identical measure of low-wage import competition finds that import competition contributes significantly to a particular measure of job loss for workers with low-levels of education. This measure of job loss identifies workers who lose a manufacturing job and find another job with lower pay in another industry. For technical reasons related to the data, this work does not observe job loss leading to unemployment. However, this measure gives a good indication of the fate of many of the workers not observed in Chapter 3. The main finding is that low-wage import competition significantly increases the likelihood of low-education workers losing their manufacturing job and finding a job elsewhere with lower wages. For workers with higher education levels, increased low-wage import competition has no significant effect on the likelihood of losing a manufacturing job and finding a lower paying job elsewhere. This suggests that if these workers were observed in the Chapter 3 inequality models, there would be a substantial group of low-education workers with lower wages added to the sample. Thus, it is likely that workers with lower levels of education are even more harshly affected by import competition than is demonstrated in Chapter 3, either through their wages or through their labor market options.

This intuition that some of the negative effects of low-wage import competition are not observed in the Chapter 3 findings is supported by other studies using different U.S. data and slightly different measures of import competition. Ebenstein et al. (2013) find that workers who leave the manufacturing sector suffer large, negative wage effects from offshoring, and Autor, Dorn, and Hanson (2012) find that import competition has a host of other negative labor market effects including increasing unemployment, decreasing labor-force participation, and increasing use of disability and other government benefits. In general, this suggests that the Chapter 3 inequality results are a baseline finding that might not reveal the full extent of the trade effects.

It is also possible that the benefits of trade are not fully captured by the observed higher wages enjoyed by high-education workers or workers in occupations complemented by task trade. The research in this dissertation does not touch on the question of real wages, only relative wages. It is still possible that the aggregate effect of trade is welfare increasing – lowering product prices enough to offset any wage decreases and increasing overall productivity by shifting production towards higher productivity products, industries, and production practices. These effects are likely, but they hold only in aggregate. What this dissertation shows clearly is that the positive and negative effects of trade are unevenly distributed, socially and geographically.

6.6 Conclusions

Contrary to the earlier consensus built on the 1990s studies, it is clear that trade does affect wages and wage inequality significantly today. But this effect is uneven. Trade appears to help some, hurt others, and does so differently across the labor force and across the country. No matter the aggregate gains from trade or how import competition may be helping certain workers, we need also to be concerned about its distributional effects. If this is the case, then it suggests policy interventions that focus not on limiting trade but rather sharing the wage and productivity gains associated with adjustments from trade competition more widely.

Bibliography

Autor, D. H., D. Dorn, and G. H. Hanson. 2012. The China Syndrome: Local Labor Market Effects of Import Competition in the United States. *National Bureau of Economic Research Working Paper Series* No. 18054.

Bernard, A. B., J. B. Jensen, and P. K. Schott. 2006. Survival of the best fit: Exposure to low-wage countries and the (uneven) growth of U.S. manufacturing plants. *Journal of International Economics* 68 (1):219-237.

Ebenstein, A., A. Harrison, M. McMillan, and S. Phillips. 2013. Estimating the Impact of Trade and Offshoring on American Workers Using the Current Population Surveys. *Review of Economics and Statistics*.

Kemeny, T., D. Rigby, and A. Cooke. 2013. Cheap Imports and the Loss of U.S. Manufacturing Jobs: SERC.

Kohler, W., and J. Wrona. 2011. Offshoring tasks, yet creating jobs? *University of Tübingen working papers in economics and finance* 12.