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A Survey of Empirical Models of Labor Transitions Following Trade Liberalization

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Abstract

In this article, we survey recent empirical studies that explain why labor markets adjust slowly after a country reduces its barriers to trade. The models that we cover are technically complex: they simulate the economy-wide transitions that result from the employment decisions of individual workers who face costs of moving between sectors, loss of the usefulness of their sector-specific experience, and many types of uncertainty. The adjustment costs in the models vary across types of workers, and the speed of adjustment varies across the countries studied and the modeling assumptions adopted. We present these technical models in a relatively non-technical way. We summarize the similarities and differences in the assumptions and findings of the different studies.

Keywords: Labor Market Transitions, Trade Liberalization, Economics Literature

[1] This article is the result of ongoing professional research of ITC Staff and is solely meant to represent the opinions and professional research of the authors. It is not meant to represent in any way the views of the U.S. International Trade Commission or any of its individual Commissioners. Please address any correspondence to David.Riker@usitc.gov. We are grateful to Rafael Dix-Carneiro for identifying this set of papers as the current state of the art in this line of research.

1. Introduction

Trade liberalization can lead to a significant reallocation of workers across sectors of the economy, as exporting sectors expand and import competing sectors contract, and the adjustments in labor markets are not costless. Transitions are impeded by the costs to workers of switching sectors, loss of accumulated experience in past jobs, and transitory unemployment during job search. The reallocation of workers is usually not completed for several years, and it is particularly difficult for less educated and older workers.

Concerns about prolonged and costly adjustment of the economy are often at the center of public debate over trade policy, but they are usually not captured in the economic models used to evaluate trade policies, because the speed and distributional consequences of the labor market adjustments are very difficult for economists to quantify. Aggregate labor relocation reflects the forward-looking and uncertain employment decisions of a large number of individual workers who can vary significantly in the adjustment costs that they face.

However, in the past few years academic economists have developed structural general equilibrium models that help to bridge this gap. These models are constructed from economic theory and are fitted to aggregate and micro-level data on the movement of workers across sectors. The models are dynamic: they predict labor market outcomes not only in the short run or in the long run but all along the transition path following trade liberalization.

In general, the models find that trade liberalization reduces input costs and increases productivity, and in the long run aggregate output and real incomes rise. Nevertheless, for all of the workers that start new jobs in exporting sectors, there are workers that lose jobs in import-competing sectors. Workers will move to the expanding sectors but their skills and training from prior jobs may be less useful. Capital investments may need to be re-tooled or discarded at a significant cost. This slows the transition of the economy.

In addition to quantifying the magnitude of these adjustment costs and estimating the speed of transition after trade liberalization, many of the models quantify the distributional effects for different types of workers, and they are used to evaluate the effectiveness of adjustment assistance to workers.

We organize the empirical studies in our survey into four sections. First, we discuss empirical models that estimate the magnitude of inter-sectoral moving costs and then use these estimates to simulate the speed of labor reallocation after trade liberalization. Second, we discuss empirical models that emphasize the effect of job search frictions on this labor reallocation. Third, we discuss a closely related set of models that examine labor market transitions in the United States and the United Kingdom in response to the large increase in imports from China. Fourth, we discuss several theoretical models of the effects of trade liberalization on the speed of labor market transitions. Finally, we conclude with a summary of the findings of the empirical studies, and we assess their policy relevance and limitations.

2. **Models of Trade Liberalization with Inter-Sectoral Moving Cost**s

The first group of models estimate the magnitude of inter-sectoral moving costs without directly measuring them, and then the authors use these moving cost estimates to simulate how the labor markets would adjust to trade liberalization.

Artuç, Chaudhuri, and McLaren (2010), the seminal paper in this line of research, models labor adjustments in the United States. The authors use a general equilibrium model with dynamic employment choices to infer the magnitude of moving costs based on inter-sectoral movement of workers in the data and an arbitrage condition: in every period in their model, each worker decides to stay in her industry or to move. The workers are indifferent on the margin, so the moving costs must reflect inter-sectoral wage differentials and potential future wages in other sectors.

Artuç, Chaudhuri, and McLaren estimate the inter-sectoral moving costs using worker-level data from the U.S. Current Population Survey for 1976-2001. Then they simulate the adjustment path of workers across sectors of the U.S. economy in response to hypothetical reductions in the price of traded goods. Their econometric estimates and subsequent simulations of labor market adjustment indicate that the inter-sectoral reallocation of labor is slow and the movement of wages in response to trade shocks is large. They estimate that inter-sectoral moving costs in the U.S. economy are more than six times as large as average annual wages.[2] The authors find that even import-competing workers can benefit from tariff reductions, since they increase the workers' their expected future wages. Given the high turnover rates in the model, a worker will likely move to other industries in the future that offer higher wages as a result of the trade liberalization.

Despite the complexity of the dynamic general equilibrium model in Artuç, Chaudhuri, and McLaren (2010), there are several important aspects of labor market adjustments that are not captured in the model.

[2] The authors report their estimates of inter-sectoral moving costs as a fraction of the worker's average annual wages as a benchmark to illustrate the economic significance of the moving costs.

First, there is no unemployment. Workers can move between sectors without engaging in job search. Second, the model relies on a *small country* modeling assumption that the prices of goods that are internationally traded are set on world markets and do not respond to supply and demand factors in the U.S. market, as if the United States were a very small country relative to the global economy.[3] The small country assumption simplifies their representation of product markets and allows the authors to focus on labor market transitions, but it also limits the usefulness of the model as a practical tool for evaluating the impact of reductions in U.S. tariffs, because it does not account for the increases in producer prices that typically accompany tariff reductions. Finally, the model includes only limited worker heterogeneity: it includes some differences between workers based on their age and level of educational attainment. The literature that has followed has built more worker heterogeneity into the models, and this provides more elaborate assessments of the distributional effects of the trade liberalization.

Dix-Carneiro (2014) builds on the modeling framework in Artuç, Chaudhuri, and McLaren (2010). His dynamic general equilibrium model includes a more extensive treatment of worker heterogeneity: workers vary in their level of education, the amount of sector-specific work experience (or human capital) that they have accumulated, and their age. In every period of the model, forward-looking workers choose a sector of employment or chose not to be employed in the formal sectors.[4] Movements between sectors are impeded by costs and also by the loss of the usefulness of their sector-specific experience. The workers' skill levels, proxied by their levels of educational attainment, are exogenous characteristics that shape their employment choices and determine aggregate labor market dynamics.[5] Dix-Carneiro uses the model to estimate trade-induced adjustments in Brazilian labor markets.

Dix-Carneiro uses a panel of matched employer-employee data from Brazil for the period 1995-2005 to estimate the magnitude of inter-sectoral moving costs. He estimates that the costs are 1.4 to 2.7 times as large as average annual wages, far below the range in Artuç, Chaudhuri, and McLaren (2010).[6] In addition, because his model includes more worker heterogeneity, Dix-Carneiro finds great dispersion in the magnitudes of these costs across the Brazilian population.

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[3] Based on this assumption, the prices of traded goods in the model are exogenously determined.

[4] With the inclusion of an informal sector, or home production, trade reforms can affect aggregate employment levels, but the model still does not include involuntary unemployment or job search.

[5] Danziger (2014) is a related study that models labor market transitions in response to trade liberalization but also endogenizes educational choices.

[6] Dix-Carneiro explains that his inclusion of sector-specific human capital accumulation accounts for much of the gap between his estimates of the magnitude of inter-sectoral moving costs and the estimates in Artuç, Chaudhuri, and McLaren (2010).

He uses the model to simulate the labor market transition following a hypothetical reduction in the price of internationally traded high-tech manufactured goods, again adopting the simplifying small country assumption that the prices of the traded goods are exogenous in the model. He estimates that the labor market transitions generally last for nine years and can be much longer if there is imperfect capital mobility across sectors. The delay in inter-sectoral reallocations reduces the aggregate welfare gains from the trade liberalization: he estimates that the adjustment costs offset 11 to 26 percent of the potential welfare gains. The impact on each worker depends on the worker's sector of employment, education, and age. He finds that inter-sectoral moving costs are higher for female, less educated, and older workers.

Dix-Carneiro also discusses several policy implications of his model. For example, he demonstrates that subsidizing moving costs creates an incentive for workers to leave contracting sectors of the economy and move to expanding sectors, and for that reason it is more effective than a retraining program that compensates displaced workers but does not create an incentive for the workers to move to the expanding sectors.

Ashournia (2014) develops a similar model to examine the adjustment of Danish labor markets in response to a globalization shock to Denmark's manufacturing sector. His model focuses on how the dynamic employment choices of workers are affected by the Danish system of unemployment insurance benefits. Ashournia uses matched worker-firm data for Denmark for 1996-2008 and a simulated minimum distance technique to estimate the parameters of his model.

He estimates that the costs of moving between sectors are 1.2 to 2.4 times as large as average annual wages, close to the estimates in Dix-Carneiro (2014). He also estimates that switching costs are higher for female, less educated, and older workers. He finds that only half of the long-run reallocation of labor occurs within the first seven years. There is slow adjustment because workers accumulate sector-specific human capital that is not transferrable, it takes time to gain experience and become productive in the new sector, and there are costs of moving between sectors. All of these factors postpone reallocations in the Danish economy. Ashournia concludes that while unemployment insurance benefits can ease the pain of labor market adjustments after trade liberalization, they also significantly impede the reallocation of resources in the economy.

Artuç, Lederman, and Porto (2015) use the analytical framework in Artuç, Chaudhuri, and McLaren (2010) to estimate inter-sectoral moving costs of workers in a large set of developed and developing countries, and they use these estimates to simulate the response of labor markets to trade policy and the welfare implications of slow transition. They develop a model of forward-looking sectoral employment choices that is based on Artuç, Chaudhuri, and McLaren (2010), but their model includes several simplifications to address data limitations that they face as they expand their analysis to the much broader set of countries. They modify the model so that it only requires aggregate data, rather than micro-level panel data, to estimate inter-sectoral moving costs. Specifically, they assume that workers have perfect foresight (an assumption that the workers perfectly anticipate the economic conditions that they will face in the future) instead of rational expectations (a less restrictive assumption that the workers know the probability distributions for future economic conditions but do not know the actual outcomes in advance), and they assume that the workers do not vary in their levels of educational attainment and accumulated sector-specific experience.

Using 1986-2007 data from the United Nations Industrial Develop Organization's Industrial Statistics Database, Artuç, Lederman, and Porto estimate moving costs by matching changes in observed sectoral employment allocations to the predicted allocations from their model using a minimum distance estimator. Artuç, Lederman, and Porto estimate that moving costs are 3.71 times as large as average annual wages in the developed countries and 2.76 times as large as average annual wages in the developing countries.[7] Their estimate for the United States is 2.21 times as large as average annual wages, one of the lowest of the countries that they model. Their simulations of hypothetical declines in world prices of food and textiles indicate that the resulting labor reallocation would take more than six years in many of the countries, but only two years in the United States.

The final study in this group is Artuç, Bet, Brambilla, and Porto (2014). The authors extend their dynamic general equilibrium models by including capital adjustment costs, firm heterogeneity, and inter-sectoral moving costs. The extended model includes firms' forward-looking decisions to accumulate capital and hire workers, as well as workers' forward-looking decisions about labor supply.[8] They calibrate the extended model to plant-level data and household survey data for Argentina. After estimating the magnitude of the capital and labor adjustment costs, they simulate the interaction (or complementarity) between changes in the prices of traded goods and adjustment costs in the domestic labor and capital markets.

Artuç, Bet, Brambilla, and Porto find that Argentina's adjustment to changes in the prices of traded goods (which they call trade shocks) depends importantly on the size of the adjustment costs (which they call domestic distortions). Reducing fixed and sunk costs of capital investment is more effective in facilitating adjustment after liberalization if the trade shocks are small, because there is a range of inaction for the

[7] These estimates of the magnitude of moving costs are larger than Dix-Carneiro's, in part because Artuç, Lederman, and Porto's model does not account for worker heterogeneity.

[8] In the extended model, they still rely on a small country assumption, and they do not attempt to model job search.

firms due to fixed and irreversible costs of investment. Under large trade shocks, reductions in moving costs are less relevant because firms have already moved out of the range of inaction and have decided to invest despite the adjustment costs.

They find that reducing fixed and sunk costs of capital investment yields a benefit that accrues mostly over the short run. Firms will eventually make the changes to the labor force and capital investments anyway, but they will make these decisions sooner if they face lower capital adjustment costs. For these reasons, there is a complementarity between trade reform and domestic distortions that is larger in the short run and for smaller trade shocks. Finally, wages are less volatile when capital adjustment costs are low, because labor and capital mobility smooths out wage spikes.

3. Models of Trade Liberalization with Labor Search Frictions

The second group of models that we survey includes job search frictions that can further slow the economies' adjustment to trade liberalization. Kambourov (2009) is an important early contribution. The author examines how institutional features of labor markets affect an economy's transition following trade liberalization. Kambourov builds a dynamic general equilibrium model, which he calibrates to data for Chile and Mexico. His small open economy model includes sector-specific human capital that is accumulated on the job, firing costs, and tariffs on imports. Costs of firing workers slow labor market adjustments. They affect hiring decisions, as well as firing decisions, since there is a probability in the model that new hires will become unproductive in the future. Consequently, firms do not fire optimally during a downturn or hire optimally during growth periods. The model includes overlapping generations of workers, and when firing costs are high they can limit labor market reallocations to the rate at which new generations of workers enter the labor force.

Based on simulations of adjustments of the Mexican economy to trade liberalization, Kambourov concludes that Mexico would have experienced a more rapid reallocation of workers across sectors and a larger increase in real output and welfare if it had liberalized its labor markets when it reduced tariffs in the 1980s.[9] He concludes that trade policy reforms should be complemented with labor market reforms.

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[9] There is some calibration to trade liberalization episodes in Chile and Mexico, but the study does not include econometric estimation of model parameters.

In a second study on the role of job search costs in labor market responses to trade liberalization, Coşar (2013) assesses the distributional and efficiency effects of alternative worker-assistance programs in Brazil. His two-sector small open economy model includes overlapping generations of workers, search frictions in labor markets, and sector-specific human capital accumulation. He calibrates the model to aggregate and micro data for Brazil in the 1980s. His model predicts slow reallocation of labor across industries, large losses for displaced workers, and a disproportional burden on older workers. In his analysis of adjustment assistance policies, Coşar finds that unemployment insurance can aggravate the short-run adverse effects of the trade liberalization by slowing labor reallocation and skill formation, but that targeted compensation programs that reward work and inter-sectoral mobility are helpful. The targeted programs help to solve a market failure: there are learning externalities (workers gain experience that makes them more valuable to future employers) and rent-sharing in the model, so the labor reallocations take too long. The targeted programs speed transition but also increase net output during the transition.

4. Models of Labor Market Adjustments to the Rise in Import Competition from China

A third group of studies examine labor market adjustments in response to the rise in import competition from China.[10] These studies do not model the impact of trade liberalization *per se*, but they are similar in their modeling approach.

Pessoa (2014) develops a dynamic multi-sector model to quantify the effects on workers and consumers in advanced countries from China's integration into the world economy, given adjustment costs in labor markets. His model of trade includes search frictions and inter-sectoral moving costs. He finds that the transition is costly for workers in import-competing sectors in the United Kingdom and the United States. They experience lower wages and increased rates of unemployment. However, aggregate welfare increases in both countries. In the United States, the rise in imports from China led to a 1.7 percent decline in real wages in the low-tech manufacturing sector five years after the rise in imports but a 2.0 percent increase in real wages in the services sector. Using detailed employer-employee panel data for the United Kingdom, Pessoa finds that increased Chinese import competition in an industry reduced the earnings of its employees, increased time that workers were out of a job, and had a greater impact on low-paid, low-productivity workers.

Caliendo, Dvorkin, and Parro (2015) use a dynamic general equilibrium model to quantify the adjustment of employment and the economic welfare of workers over time and across U.S. states in response to the

[10] These studies are dynamic analyses of the "China Syndrome" in Autor, Dorn, and Hanson (2013).

rise in import competition from China. Their model includes job search frictions, heterogeneous firms, and spatially distinct labor markets with varying exposure to domestic and international trade. Unlike the other models that we have surveyed, Caliendo, Dvorkin, and Parro's model includes a detailed treatment of input-output linkages within the U.S. economy.

They calibrate the model to 38 countries, 50 U.S. states, and 22 sectors.[11] They use data from the World Input-Output Database and the U.S. Commodity Flow Survey. The estimates in Caliendo, Dvorkin, and Parro (2015) are similar to those in Pessoa (2014), despite differences in the structure of their models. The reduction in real wages in the low-tech manufacturing sector in the United States is slightly lower than Pessoa's. They find that the U.S. economy is better off due to cheaper imported goods, even though exposure to imports from China reduced the share of manufacturing in total U.S. employment by 0.6 percentage points. They estimate that imports from China increased aggregate U.S. economic welfare by 0.2 percent in the short run but by 6.7 percent over the long run. Their model indicates that the magnitudes of the labor market effects are very different across sectors and also across states.

5. Theoretical Models of Trade Liberalization and Labor Market Adjustment

In this section, we briefly discuss a group of studies that are closely related but are theoretical rather than empirical in their focus. Cacciatore (2014) models the adjustments to trade liberalization between two countries that have different degrees of flexibility in their labor markets. Trade liberalization results in temporary unemployment. Labor market rigidities reduce the gains from trade, but they also mitigate short-run employment losses.

Itskhoki and Helpman (2014) develop a model with heterogeneous firms and search frictions in labor markets. They show that productivity, output, and trade flows are depressed during the transition after trade liberalization due to the search frictions.

Finally, Lechthaler and Mileva (2014) analyze alternative policies for compensating workers that are harmed in the short term as an economy adjusts to trade liberalization. They find that wage, consumption, and profit taxes that redistribute income between skilled and unskilled workers reduce incentives for the working to retrain. While the taxes can mitigate the effect of the trade liberalization on wage inequality, they also reduce the output of the economy during the transition.

These theoretical models illustrate important conceptual issues, and they also develop structural models that might be tested into future empirical analyses.

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[11] Their data-intensive modeling framework includes 1,150 distinct state-sector labor markets in the United States.

6. Conclusions

We have surveyed several of the newest empirical models of labor transitions after trade liberalization. Many are already published in top academic journals and others are well on their way. These studies provide quantitative estimates for a diverse set of national economies, including Argentina, Brazil, Chile, Denmark, Mexico, and the United States. Most of the studies estimate the magnitude of inter-sectoral moving costs and also the speed of labor market adjustment following a trade liberalization. The key findings from the empirical studies are summarized in the following table:

Summary of the Main Findings of the Empirical Studies

Author(s) and Year	**Main Findings**
Artuç, Chaudhuri, and McLaren (2010)	Workers in the **United States** face very large costs of moving between sectors. Trade liberalization results in slow reallocations and sharp movements in wages, but even workers in import-competing sectors can be better off.
Dix-Carneiro (2014)	Inter-sectoral moving costs in **Brazil** are 1.4 to 2.7 times average annual wages. Transitions following trade liberalization can take more than nine years.
Ashournia (2014)	Inter-sectoral moving costs in **Denmark** are 1.2 to 2.4 times average annual wages. Switching costs are higher for female, less educated, and older workers. Only half of the reallocation occurs within the first seven years.
Artuç, Lederman, and Porto (2015)	Inter-sectoral moving costs are 3.71 times annual wages in the developed countries and 2.76 times annual wages in the developing countries. The costs in the **United States** are 2.21 times annual wages. This is one of the lowest of the countries included in the model.
Artuç, Bets, Brambilla, and Porto (2014)	The adjustment of **Argentina's** economy to changes in the prices of traded goods depends importantly on the size of adjustment costs in the country's labor and capital markets.
Kambourov (2009)	Hiring and firing costs and sector-specific human capital accumulation slows the inter-sectoral reallocation of labor. Labor market reforms complemented trade reforms in **Chile**, but lack of labor reforms led to prolonged stagnation after tariff reductions in **Mexico**.
Coşar (2013)	There is a slow reallocation of labor across industries in **Brazil** and a large burden on displaced workers and older workers due to job search frictions and sector-specific human capital accumulation. Targeted compensation that encourages inter-sectoral mobility to new jobs helps the economy to adjust.
Pessoa (2014)	The surge in imports from China resulted in a 1.7% decline in real wages in the low-tech manufacturing sector in the United States after five years of adjustment, but a 2.0% increase in real wages in the services sector. There is an overall welfare increase in the **United States** and the **United Kingdom**. The impact is larger on workers who are female, less educated, or older.
Caliendo, Dvorkin, and Parro (2015)	They find that the **United States** economy is better off due to cheaper imported goods, though exposure to imports from China reduced the share of manufacturing in total U.S. employment by 0.6 percentage points. They estimate that "China's shock increases U.S. welfare by 6.7% in the long-run and by 0.2% in the short-run with very heterogeneous effects across labor markets."

This is a line of economic research that is potentially very relevant to policy-makers. The next generation of these models will no doubt build on these studies, adding more structural detail to the models and hopefully even better data. Even if the specific findings in the table above do not hold in further research, these studies have made important methodological contributions to the economics literature: they develop a set of modeling assumptions that yield complex yet tractable modeling frameworks and methods for estimating the parameters of the model from available data.

The main limitation of these models as a tool for evaluating the impact of actual trade policies in countries like the United States is that nearly all of the models adopt a small country assumption, treating the prices of internationally traded goods as exogenous variables, and the trade liberalization scenarios in the studies are in most cases hypothetical.[12] The authors adopt the small country assumption about product markets in order to maintain tractability while focusing on the complex dynamic decision-making in factor markets. However, the prices of traded goods in the United States do respond to conditions in the U.S. market, including dislocation and reallocation in labor markets, so these additional general equilibrium effects on the prices of traded goods are part of the impact of trade liberalization that is not yet captured in this line of models.

[12] The models in Pessoa (2014) and Caliendo, Dvorkin, and Parro (2015) focus on the U.S. market and do not impose a small country assumption, but they model the rise in imports from China. They do not model specific trade policies.

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