

# Trade Reforms, Foreign Competition, and Labor Market Adjustments in the U.S.

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## Abstract

In contrast to standard trade theory, I document that locations facing more foreign competition in the U.S. have: higher job destruction rates, lower job creation rates, and thereby experience higher unemployment rates. To account for these facts, I introduce a simple trade model with unemployment and segmented local labor markets. Import competition has a correlated effect on job destruction and job creation because the most vulnerable also have lower productivity. After an unexpected trade liberalization with limited labor mobility, employment sharply falls in the worse hit locations even though aggregate welfare gains are positive.

Keywords: trade, foreign competition, unemployment, geographic inequality

JEL classification: F16, F66, G64

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# 1 Introduction

In standard models of international trade, the reallocation of production factors is at the heart of the gains from trade. The effects of trade reforms therefore depend crucially on how these factors are reallocated. While cross-country mobility of labor and capital has been extensively investigated in the trade literature, the differences in reallocation within countries have been less studied. In particular, in standard trade models, labor markets are centralized and typically frictionless. Standard trade theory also does not consider geographic variations in the unemployment effects of trade reforms. However, recent evidence such as [Autor, Dorn, and Hanson \[2011\]](#) indicates that the labor market effects of trade are uneven across locations. This paper makes empirical and theoretical contributions to the literature on international trade and labor markets.

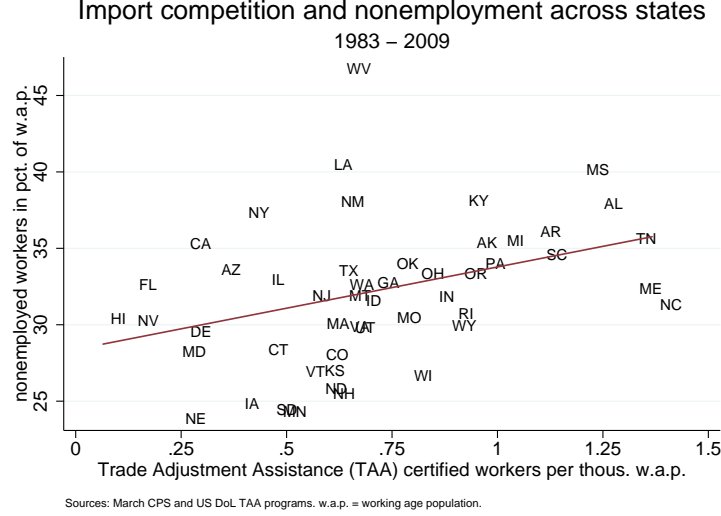
First, this paper establishes new facts on the impact of foreign competition on non-employment and job flows using variations in import competition across locations in the U.S. Second, this paper introduces a new trade model with unemployment and local labor markets that face varying degrees of foreign competition (head-to-head versus monopolistic competition). This model is used to rationalize the observed effects of trade-induced foreign competition across locations and to evaluate the welfare effects from trade liberalization.

In practice, it is hard to measure job losses caused by import competition. Consider, for instance, a shipment of electronic parts imported from China arriving at the port of Savannah in Georgia. It is not obvious to determine which American workers and which plants are displaced because of these Chinese imports. In this paper, I create a novel state-level panel dataset on job losses due to foreign competition since 1983 based on data from the U.S. Department of Labor Trade Adjustment Assistance (TAA) programs. These programs investigate all the establishment-level petitions submitted on behalf of workers that were deemed displaced due to import competition. [Figure 1](#) illustrates the average import competition and the average nonemployment rate across states from 1983 to 2009 using the Trade Adjustment Assistance (TAA) data and the Current Population Survey (CPS).

I find that, across locations, import competition is associated with reduced employment. Import competition has a correlated impact on the job destruction rate and the job creation rate: locations that face more foreign competition not only have a higher job destruction rate but also a lower job creation rate. Import competition therefore has a large differential impact on unemployment across locations. In fact, across two different locations, one extra worker displaced due to import competition is associated with an overall unemployment differential of three workers. The results are robust to state fixed effects, time fixed effects,

panel-level autocorrelation and heteroskedasticity<sup>1</sup>.

Figure 1: Nonemployment and import competition in the U.S.



Most importantly, the measured unemployment effects of trade across locations imply that models capturing these empirical effects are needed to evaluate the welfare effects of trade and to provide an explanation for the documented facts. This paper extends a model of international trade with imperfect competition to incorporate unemployment and local labor markets facing different levels of foreign competition. The model is then calibrated to evaluate the effects of an unexpected trade reform on labor markets and welfare across locations.

At the heart of the model with unemployment, there is a hybrid model of trade which combines monopolistic competition and direct head-to-head competition. The model is hybrid in the sense that some firms monopolistically produce differentiated varieties that have no perfect substitute (see [Dixit and Stiglitz \[1977\]](#)) while other firms produce differentiated varieties that have a perfect foreign substitute (see [Dornbusch, Fischer, and Samuelson \[1977\]](#) and [Bernard, Eaton, Jensen, and Kortum \[2003\]](#)). Hence, some firms do not face direct foreign competition while others face direct foreign competition making them vulnerable to shutdowns when trade barriers fall.

On top of this hybrid trade model, there is a continuum of locations and local unemployment. In adding locations to the model, the main goal is to have differences across locations in their vulnerability to foreign competition. This is accomplished via exogenous productivity differences across locations in the Ricardian tradition. Local unemployment

<sup>1</sup>Figure 14 on page 45 in the appendix depicts this relationship across deciles of import competition.

is obtained using random Leontief matching and collective Nash bargaining within labor markets. Across labor markets, workers are allocated, ex ante, so that they are indifferent among these locations. However, following an unexpected reform, these workers can switch employers but they cannot change locations.

The heterogeneity in the level of foreign competition across these segmented labor markets is a key ingredient to explain the association between import competition and unemployment through job creation and job destruction. In fact, an unexpected reduction in trade frictions unevenly impacts these heterogeneous locations. Domestic firms in the less productive areas face fiercer foreign competition and have more job losses because many local firms shut down. These job losses partly contribute to differences in unemployment across locations since these locations differ in degree of foreign competition. The model delivers an additional effect of import competition on job creation across locations because the most vulnerable locations to foreign competition also have lower productivity and thereby create fewer new jobs.

Consequently, the overall welfare effects of a trade reform will depend on the combined effects of job destruction and job creation. I evaluate the welfare effects of an unexpected trade liberalization using the model calibrated to the U.S. economy. The main calibration target is the total number of workers displaced because of import competition. The trade liberalization yields aggregate welfare gains along with large reductions in employment rate and earnings in the badly hit local labor markets: some locations gain while other locations hurt a lot. However, these aggregate welfare gains disappear following an unexpected rise in foreign productivity because even the most productive domestic firms can shut down due to increased foreign competition.

This paper is structured as follows. Section 2 discusses this paper's relation to the existing literature. Section 3 empirically analyzes import competition and labor market outcomes and job flows across states in the U.S.. Section 4 provides a simple static model showing the uneven impact of trade competition on unemployment across segmented labor markets that differ in foreign competition. Section 5 contrasts the welfare effects of an unexpected trade liberalization and an unexpected increase in foreign productivity when workers cannot ex post switch locations. Section 6 concludes.

## 2 Related Literature

This paper contributes to a growing literature that bridges international trade and labor economics. Following the contributions of [Topalova \[2007\]](#) and [Kovak \[2010\]](#) on the impact of trade liberalization on migration and wages in India and Brazil respectively, [Autor, Dorn, and Hanson \[2011\]](#) made an influential contribution by conducting a thorough empirical

analysis of the impact of increased in trade with China on local U.S. labor market outcomes. They document the “China syndrome”: the worsening of labor market outcomes in localities that are more exposed to growing imports from China due to their local industrial mix.

The models used to motivate the existing empirical studies on trade and unemployment do not feature local unemployment. This paper introduces a model of trade with local unemployment. In fact, this paper features the first model of unemployment with variable markups in the trade literature. Also, this paper introduces the first direct measure of local job displacements due to foreign competition in the trade and labor literature. This measure uses local displacements attributed to foreign competition in contrast with the standard local import penetration proxies that are inferred from aggregate national data. [Margalit \[2011\]](#) recently constructed a similar local measure for a novel use in the political science literature: the effects of job losses due to foreign competition on anti-incumbent voting behavior during the elections cycles. [Yotov \[2007\]](#) and [Uysal and Yotov \[2011\]](#) first used the underlying petition data in the trade literature to measure trade-induced job losses by industry and firm. This paper instead introduces a location-specific measure to study the labor markets effects of trade across locations.

This paper is also related to the empirical literature on of exchange rate shocks and job flows. Following the work of [Goldberg and Tracy \[2000\]](#) on exchange rates and local labor markets, studies such as [Klein et al. \[2003\]](#) and [Moser et al. \[2010\]](#) empirically document the effects of foreign competition on job creation and job destruction using real exchange fluctuations as exogenous shifters of foreign competition. In this paper, I find that foreign competition has correlated effects on both job destruction rates and job creation rates.

This paper is related to the theoretical models of trade and unemployment. In particular, [Davidson et al. \[1999\]](#) showed that labor market institutions are an important determinant of international comparative advantage. [Helpman and Itskhoki \[2010\]](#) extended this approach to the [Melitz \[2003\]](#) model of international trade with monopolistic competition and heterogeneous firms. [Janiak \[2006\]](#), [Egger and Kreckemeier \[2009\]](#), [Mitra and Ranjan \[2010\]](#), and [Felbermayr et al. \[2010\]](#) also introduce unemployment in the baseline models of international trade. Recently, [Dutt et al. \[2009\]](#) and [Felbermayr et al. \[2011\]](#) studied the effects of trade openness on labor market outcomes across countries using model of trade and unemployment. Also, [Kambourov \[2009\]](#), [Cosar \[2010\]](#), and [Dix-Carneiro \[2010\]](#) recently studied transition paths in dynamic models of trade and unemployment with a rich notion of sectoral and human capital heterogeneity within a country.

In this paper, I complement these studies by introducing unemployment across heterogeneous local labor markets varying in the degree of import competition they face. Furthermore, this paper introduces a hybrid model of international trade combining the Cham-

berlinian monopolistic competition model with head-to-head competition akin to [Bernard, Eaton, Jensen, and Kortum \[2003\]](#). This paper also introduces variable markups and segmented local labor markets in a framework similar to [Helpman and Itskhoki \[2010\]](#). In this paper, as in [Helpman and Itskhoki \[2010\]](#), the ex ante indifference condition of workers across labor markets is reminiscent of [Harris and Todaro \[1970\]](#) and [Lewis \[1954\]](#).

## 3 Evidence

This section presents the main empirical findings: import competition is associated with higher unemployment, lower labor force participation, higher job destruction rates, lower job creation rates, and longer unemployment spells. Furthermore, the labor market effects of import competition magnify the displacements directly due to foreign competition. These findings are based a state-level panel dataset created using the petitions data from the U.S. Trade Adjustment Assistance (TAA) programs for workers<sup>2</sup>.

### 3.1 Data Description

#### The March CPS

I construct, for every year  $t = 1983 \dots 2009$  and for every state, the following labor market outcomes: unemployed per working age population, not in the labor force per working age population, and average unemployment duration. I use public data from the Current Population Survey (CPS). In particular, I use data from the Annual Social and Economic Supplement (ASEC) applied to the sample surveyed in March and assembled into the Integrated Public Use Microdata Series by [King et al. \[2010\]](#).

#### The Business Dynamics Statistics

I also obtain, for every year  $t = 1983 \dots 2009$  and for every state, the following labor market outcome counterparts: jobs destruction rate, job creation rate, and net job creation rate. These measures are computed following [Davis, Haltiwanger, and Schuh \[1998\]](#) and they are obtained from public data from the Business Dynamics Statistics (BDS). The BDS are created from the Longitudinal Business Database (LBD) by the Census Bureau. The BDS contain annual series describing establishment-level business dynamics.

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<sup>2</sup>I choose to aggregate the petition data at the state level because of the greater reliability of other macroeconomic series at the state level. In a companion project, I conduct empirical investigations on the labor market effects of trade at the commuting zone level.

## The Trade Adjustment Assistance (TAA) programs for workers

To measure import competition at the state-level, I construct a novel state-level panel dataset based on the Trade Adjustment Assistance (TAA) programs for workers. The international trade literature had not previously used this direct and local measure of foreign competition<sup>3</sup>.

Instated in its current form as part of the pivotal Trade Act of 1974, the Trade Adjustment Assistance (TAA) for workers is a federal program that aims to support the professional transition of workers displaced due to foreign trade. [Rosen \[2006\]](#) and [Rosen \[2008\]](#) provide a detailed history of the program. I use data on the number of workers certified under this program by the Department of Labor (DoL) to have been displaced due to foreign trade from 1983 to 2009.

Firms, unions, state unemployment agencies, or groups of workers can file a petition on behalf of a group of workers at a given establishment to be eligible for Trade Adjustment Assistance (TAA) benefits. These benefits include: Trade Readjustment Assistance (TRA) for up to two years as long as the workers are enrolled in training, income support for the workers who are find full employment following the trade-induced separations, job search allowances, relocation allowances, and healthcare assistance.

To establish the eligibility of the petitioning workers, federal investigators at the Department of Labor (DoL) seek evidence that these workers were separated because of (a) import competition that led to decline in sales or production, (b) a shift in production to another country with which the United States has a trade agreement, or (c) due to loss of business as an upstream supplier or downstream producer for another producer that is TAA-certified. For each petition, investigators make a “confidential data request” (CDR) for data such as sales history, sales of import-competing products, major declining customers and unsuccessful bids. The Trade Adjustment Assistance (TAA) investigators also have legal power to subpoena if the company does not comply to the data request. All the workers covered by an approved petition become eligible for the Trade Adjustment Assistance (TAA) benefits.

I construct measures of trade-induced foreign competition using data on all establishment-level petitions filed under the program up to 2009. I exclude data prior to 1983 due to the lack of reliability of these data as a measure of import competition (see [Rosen \[2006\]](#)). Each

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<sup>3</sup>As discussed in the literature review, [Margalit \[2011\]](#) constructs a similar measure in the political science literature. [Yotov \[2007\]](#) and [Uysal and Yotov \[2011\]](#) are also precursors in the use of the petitions data from the Trade Adjustment Assistance (TAA). [Decker and Corson \[1994\]](#) use survey data on the characteristics and the outcomes individual workers receiving Trade Adjustment Assistance (TAA) benefits in 1988 to study the impact of a reform emphasizing training. Numerous reports and studies such as [Magee \[2001\]](#) and [Park \[2011\]](#) use similar survey data on worker characteristics and the design of the Trade Adjustment Assistance (TAA) to assess the effectiveness of the program itself. These studies and reports do not use the establishment-level certification data used in this paper and do not consider the aggregate labor markets effects of foreign competition.

petition includes information on the location of the establishment, the numbers of workers affected, the certification decision, and the date of impact<sup>4</sup>.

### 3.2 Measuring Import Competition

Using the Trade Adjustment Assistance (TAA) petitions data, for every year  $t = 1983 \dots 2009$  and for every state  $i$  in the U.S., I measure the degree of import competition at a given location and at a given time as the ratio of all workers newly certified for Trade Adjustment Assistance (TAA) relative to the working age population:

$$\text{TAA import pressure}_t^i \equiv \frac{\sum_{\text{plants } j \in i} \text{Trade Adjustment Assistance (TAA) certified workers}_{j,t}^i}{\text{working age population}_t^i}$$

In 2009, a record 330,906 workers were certified for Trade Adjustment Assistance (TAA) across all states. Figure 12 in the appendix shows an overview of the total number of TAA certified workers in the U.S. over time. Table 1 and Figure 2 show the typical order of magnitude of this TAA-based import pressure across states between 1983 and 2009. Table 1 in the appendix shows detailed descriptive statistics by state.

Table 1: Summary statistics (1983-2009)

| Variable                                      | p10   | p25   | p50   | p75  | p90  |
|---|-------|-------|-------|------|------|
| TAA certified workers (per thousand w.a.p.)   | 0.03  | 0.17  | 0.43  | 0.88 | 1.64 |
| TAA petitioning workers (per thousand w.a.p.) | 0.11  | 0.39  | 0.80  | 1.43 | 2.38 |
| Unemployed minus US average (percent w.a.p)   | -2.24 | -1.33 | -0.35 | 0.79 | 1.99 |

It is important to note that this measure is expressed in workers displaced and therefore is different from the standard import penetration proxies used in the literature. Typically, the import penetration proxies are expressed in dollars per worker by taking a weighted average of country-wide imports by industrial classification.

In fact, it is not obvious to map country-level imports to the plants that are most directly affected. It is not clear which plants in the U.S. are directly affected by a shipment of toys coming through the port of Savannah. Import penetration proxies are widely used in economics and rely on the local industrial mix data to infer the local import competition. These proxies implicitly assume that two plants producing toys are equally in the U.S. are equally impacted by the Chinese imports, thereby ignoring differences in productivity

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<sup>4</sup>Individual petitions are publicly available at [http://www.doleta.gov/tradeact/taa/taa\\_search\\_form.cfm](http://www.doleta.gov/tradeact/taa/taa_search_form.cfm)



between these plants. In other words, the standard proxy may wrongly infer that the more productive plant is shrinking in size as much the less productive plant.

For instance, the “China syndrome” measure used in [Autor, Dorn, and Hanson \[2011\]](#) - henceforth ADH - is an local import penetration measure obtained as a weighted average of U.S. imports using the local labor force shares by industry as weights:

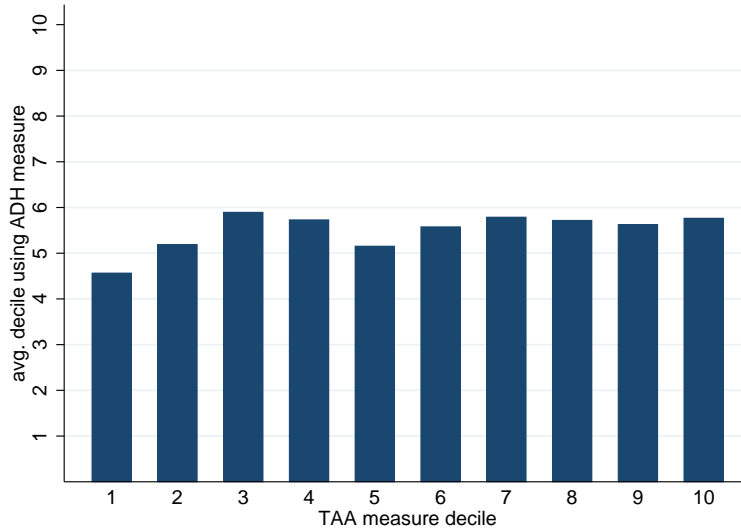
$$\text{ADH import penetration}_t^i \equiv \sum_{\text{industries } k} \underbrace{\frac{\text{employment}_{i,t}^k}{\text{employment}_{i,t}}}_{\text{local industrial mix}} * \underbrace{\frac{\Delta \text{imports}_{US,t}^k}{\text{employment}_{US,t}^k}}_{\text{national imports}}$$

Table 2 shows the typical order of magnitude of this TAA-based import pressure across states between 1988 and 2005<sup>5</sup>.

Table 2: Summary statistics (1988-2005)

| Variable  | p10  | p25  | p50  | p75  | p90  |
|---|------|------|------|------|------|
| Change in China import exposure (\$000s per worker) | 0.12 | 0.25 | 0.56 | 1.38 | 2.70 |

Figure 2: Import penetration proxy and import competition at the state-level



This measure exhibits variations at the state level that are not captured by [Autor, Dorn, and Hanson \[2011\]](#) as shown in Figure 2<sup>6</sup>. By using a direct measure of import competition

<sup>5</sup>The China exposure is computed following Autor, Dorn, and Hanson (2011) for 1988-1997 and 1999-2005 only due to data limitations.

<sup>6</sup>Figure 16 in the appendix shows the detailed state-level time series.

in terms of job displacements, I circumvent the non-trivial inference that is implicit in the import penetration proxy.

Using this measure, I assess the relation between foreign competition and labor market outcomes in the next section.

### 3.3 Impact of Import Competition on Labor Market Outcomes

#### Unemployment

The relationship between import competition and unemployment is not obviously positive. The magnitude of this relationship is even less obvious.

To assess the impact of import competition on unemployment, I estimate the regression specified below:

$$\text{not employed}_t^i = \alpha + \beta \times \text{import pressure}_t^i + \gamma \cdot \text{controls}_t^i + \text{error}_t^i$$

where  $i$  denotes a state,  $t$  denotes a year between 1983 and 2009. I also separately estimate each of the simple linear regressions specified below to distinguish the unemployment effect from the non labor force participation margin:

$$\text{unemployment}_t^i = \alpha + \beta \times \text{import pressure}_t^i + \gamma \cdot \text{controls}_t^i + \text{error}_t^i$$

$$\text{not in labor force}_t^i = \alpha + \beta \times \text{import pressure}_t^i + \gamma \cdot \text{controls}_t^i + \text{error}_t^i$$

where  $i$  denotes a state,  $t$  denotes a year between 1983 and 2009.

The variable “import pressure $_t^i$ ” is the number of workers certified by the Trade Adjustment Assistance (TAA) in state  $i$  *during* year  $t$  relative to that state’s working age population. The dependent variable “not employed $_t^i$ ” is the number of workers who are not employed in state  $i$  *as of* the March CPS in  $t+1$  relative to that state’s working age population. The dependent variable “unemployment $_t^i$ ” is the number of unemployed in state  $i$  *as of* the March CPS in  $t+1$  relative to that state’s working age population. Similarly, the variable “not in labor force $_t^i$ ” is the number of people not in the labor force in state  $i$  *as of* the March CPS in  $t+1$  relative to that state’s working age population.

At the state level, I assume there is first-order autocorrelation AR(1) in the error terms and that the coefficient of the AR(1) process is common across states. Furthermore, the errors are assumed to be panel-level heteroskedastic. Hence, the standard errors reported here are robust to panel-level heteroskedasticity. The controls include: state fixed effects, year fixed effects, the state log income per working age population, and the state share

of U.S. working age population. Other controls such as the state unionization rate, the state-specific Trade Adjustment Assistance (TAA) approval rate, and the standard import penetration proxies are included in the subsequent robustness checks. The findings below are robust to alternative specifications with lagged variables or changes in non-employment instead of auto-correlated errors.

The first specification yields the following estimate using a Prais-Winsten regression to generate robust standard errors:

$$\text{not employed}_t^i = \alpha + \underset{(0.780)}{3.349 \times \text{import pressure}_t^i} + \gamma \cdot \text{controls}_t^i + \text{error}_t^i$$

$$R^2 = 0.8633$$

$$N = 1350$$

The related regressions on unemployment and non labor force participation yield the following estimates<sup>7</sup>:

$$\text{unemployment}_t^i = \alpha + \underset{(0.553)}{1.409 \times \text{import pressure}_t^i} + \gamma \cdot \text{controls}_t^i + \text{error}_t^i$$

$$R^2 = 0.6345$$

$$N = 1350$$

$$\text{not in labor force}_t^i = \alpha + \underset{(0.617)}{2.187 \times \text{import pressure}_t^i} + \gamma \cdot \text{controls}_t^i + \text{error}_t^i$$

$$R^2 = 0.8588$$

$$N = 1350$$

The coefficients estimated indicate a large differential effect of foreign competition on labor markets: across locations, an extra worker separated due to import competition is associated with an additional difference in the overall non-employment of two to three extra workers. A world with frictionless reallocation would imply that the import pressure should have no effect on the unemployment level. A world in which these workers stay unemployed

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<sup>7</sup>The coefficients do not add up to the coefficient in the non-employment regression. This is simply because the errors are assumed to be autocorrelated and the persistence parameters estimated are not exactly the same across these regressions.

for four months<sup>8</sup> would imply a coefficient less than one if most of these workers permanently transition back into employment. The coefficient estimated is therefore very large. These findings indicate that the workers certified by the Trade Adjustment Assistance (TAA) are only a symptom of foreign competition: differences in unemployment magnify differences in job losses due to foreign competition across locations.

While these results confirm and extend our interpretation of the findings reported in Autor, Dorn, and Hanson [2011], it is worth noting that the findings of Autor, Dorn, and Hanson [2011] do not hold at the state-level. The standard import penetration proxy has limitations when it is used at an aggregate level, in addition to some of the conceptual limitations discussed in the previous subsection. On the other hand, the estimates reported in this paper using the new measure of import competition are robust to the inclusion of the standard import penetration as an additional control.

## Job Destruction Rate and Job Creation Rate

To further document the labor market effects of trade across locations, I study the effects of import competition on job flows. The Business Dynamics Statistics (BDS) distinguish between job destruction and job creation following the definition of Davis, Haltiwanger, and Schuh [1998]. Davis, Haltiwanger, and Schuh [1998] nicely explain the importance of using plant-level data to decompose change in unemployment into two separate margins: the destruction of existing jobs and the creation of new jobs.

I find that the unemployment effects of import competition are explained by both higher job destruction and lower job creations as shown below:

$$\text{job destruction rate}_t^i = \alpha + 1.819 \times \text{import pressure}_t^i + \gamma \cdot \text{controls}_t^i + \text{error}_t^i$$

(0.724)

$$R^2 = 0.7955 \qquad N = 1350$$

$$\text{job creation rate}_t^i = \alpha - 1.276 \times \text{import pressure}_t^i + \gamma \cdot \text{controls}_t^i + \text{error}_t^i$$

(0.630)

$$R^2 = 0.7717 \qquad N = 1350$$

These findings on job flows bridge two strands of the literature on trade and jobs: the first

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<sup>8</sup>The average unemployment spell is 16 to 17 weeks.

one studies the unemployment effects of trade using import penetration proxies while the other studies the effects of real exchange rate fluctuations on job flows. The existing papers do not agree that real exchange rate fluctuations affect both job creation and job destruction as shown in [Klein et al. \[2003\]](#) and [Moser et al. \[2010\]](#). This paper documents, empirically and theoretically, the correlated effects of import competition on both job destruction and job creation in the U.S. in agreement with the net effect on unemployment.

## Summary

Using a state-level panel dataset with a direct measure of foreign competition, I document a large differential effect of foreign competition across locations. Across locations, increased foreign competition is associated with increased unemployment.

This difference in unemployment across locations is driven by the dual effects of import competition on both job destruction and job creation. Overall, the effects documented above are robust to the inclusion of more controls, in particular the state level unionization rate, the state level contemporaneous Trade Adjustment Assistance (TAA) approval rate, and the widely use import penetration proxy.

Other labor market outcomes such as hourly wages, hours worked and the skill premium are not significantly impacted by this measure of import competition even though unemployment spells slightly increase with import competition. Finally, import competition does not significantly alter population dynamics as shown in the appendix.

These findings provide a new understanding on the uneven impact of trade across locations. However, these empirical findings also trigger questions that warrant a model: why does foreign competition have a correlated effect of both job destruction and job creation? what are the welfare effects of the uneven effect of foreign competition across locations? what are the consequences of the limited geographical mobility of workers in response to trade shocks? Unfortunately, standard trade theory is not equipped to address some of these questions. In this next section, I propose a new model to tackle these questions.

## 4 A Trade Model with Heterogeneous Labor Markets

In the following section, I build a model of international trade and local unemployment to address the questions motivated by the empirical findings and to ultimately evaluate the effects of trade reforms and changes in foreign productivity. Specifically, I introduce head-to-head competition, segmented local labor markets in a hybrid trade model. The hybrid trade model combines some firms monopolistically producing differentiated varieties with no perfect substitute (see [Dixit and Stiglitz \[1977\]](#)) and other firms producing differentiated

varieties with a perfect foreign substitute (see [Dornbusch, Fischer, and Samuelson \[1977\]](#) and [Bernard, Eaton, Jensen, and Kortum \[2003\]](#)).

The economy features a continuum of locations or islands that vary in the exogenous productivity of their local firms, thereby inducing differences in the degree of foreign competition. Local unemployment is obtained using random matching of workers to firms and collective Nash bargaining while the distribution of population across locations is determined by the uncoordinated search for work across locations. This structure therefore has similarities with [Alvarez and Shimer \[2010\]](#) who consider a competitive equilibrium setup with directed search across many islands and random matching within each island. Effectively, this model introduces variable markups and local labor markets in the framework of [Helpman and Itskhoki \[2010\]](#).

In this section, I layout the model in detail and characterize the equilibrium allocation. I use this model to study the effects of an unexpected trade reform in the next section.

## 4.1 Environment

The environment consists of two symmetric<sup>9</sup> countries  $j = 0, 1$  populated by a unit measure of families and firms. Each family<sup>10</sup> is composed of  $L$  (potential) workers allocated across the towns of their home country.

### Preferences

Each family has quasi-linear preferences over its homogeneous good consumption  $q_0$  and its composite good consumption  $Q$ :

$$U = q_0 + \frac{1}{\eta} Q^\eta$$

where  $Q$  is the Spence-Dixit-Stiglitz aggregator over differentiated goods  $\nu \in M_0 \cup H \cup M_1$ :

$$Q \equiv \left( \int_{M_0 \cup H \cup M_1} q(\nu)^{\frac{\sigma-1}{\sigma}} d\nu \right)^{\frac{\sigma}{\sigma-1}}$$

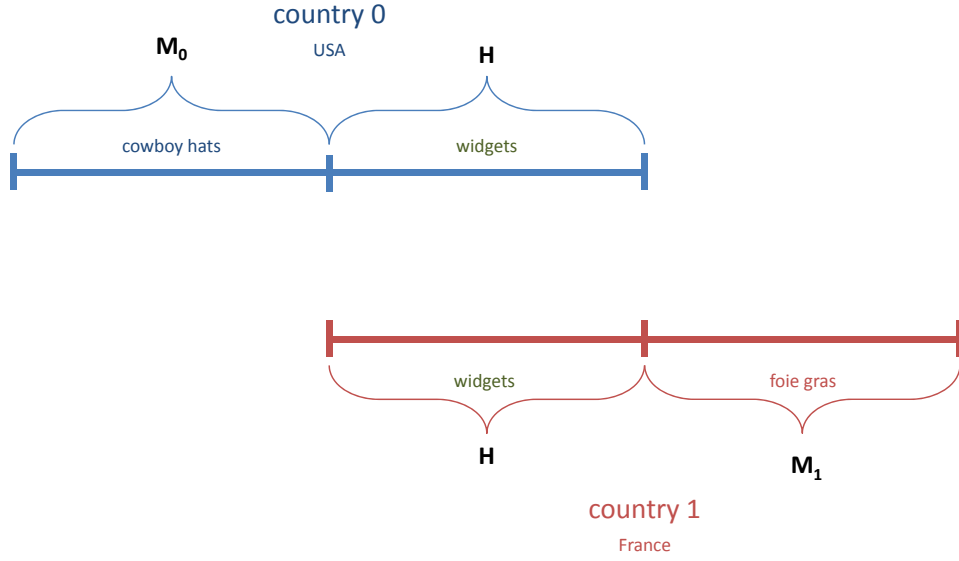
and  $0 < \eta < \frac{\sigma-1}{\sigma} < 1$ .

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<sup>9</sup>In the next section, this assumption is relaxed to consider the effects of asymmetries in productivity.

<sup>10</sup>As in [Helpman and Itskhoki \[2010\]](#), the family interpretation is essential in the case of quasi-linear preferences but not when preferences are homothetic.

Figure 3: A simple overview of the model



The differentiated goods have two possible types as illustrated in Figure 3:

- the monopolistic  $M$ –goods have no foreign counterpart and the producers of these goods are monopolistic competitors (e.g. cowboy hats and foie gras respectively), or
- the head-to-head  $H$ –goods have a perfect substitute produced by a foreign competitor and the domestic producer of these goods competes head-to-head for domestic and foreign markets (e.g. widgets or even wine).

For simplicity, one can think of Texas towns and Pennsylvania towns making cowboy hats and widgets respectively.

Taking the homogeneous as the numeraire ( $p_0 = 1$ ), the household faces a price index  $P$  for the differentiated good defined as:

$$P = \left( \int_{M_0 \cup H \cup M_1} p(\nu)^{1-\sigma} d\nu \right)^{\frac{1}{1-\sigma}}$$

A household with total income  $R$  therefore chooses:

$$\begin{aligned} q_0 &= R - P^{-\frac{\eta}{1-\eta}} = R - Q^\eta \\ Q &= P^{-\frac{1}{1-\eta}} \\ q(\nu) &= Q^{-\frac{\rho-\eta}{1-\rho}} p(\nu)^{-\sigma} \end{aligned}$$

where  $\rho \equiv \frac{\sigma-1}{\sigma} \equiv \frac{1}{\mu}$  and the household income  $R$  is the sum of total wage earnings and the dividends it receives from domestic firms.

## Technology and Competition

Each  $M$ -type producer is a monopolistic competitor. In contrast, each  $H$ -type producer faces head-to-head competition from a unique foreign counterpart. An  $H$ -type (head-to-head) producer competes with its competitor via simultaneous price setting given the productivity of their rival. This form of head-to-head competition is similar [Bernard, Eaton, Jensen, and Kortum \[2003\]](#) with the distinction that there is no domestic head-to-head competitor in this model.

The total measure of varieties (and firms) is fixed (and normalized to 1 to shutdown the effect of the total number of varieties on the price index<sup>11</sup>). There is an exogenous measure  $H$  of  $H$ -type (head-to-head) firms and an exogenous measure  $M$  of  $M$ -type firms. Given this structure, the model is effectively a hybrid setup combining the Chamberlinian monopolistic competition with head-to-head imperfection competition. These two modes of international competition emerge as special cases of the setup ( $H = 0$  and  $H = 1$  respectively)<sup>12</sup>. A model that includes only monopolistic competitors without direct foreign competition will fail to match the data: it cannot generate job losses due to foreign competition. A model without monopolistic competitors, on the other hand, may overstate the effects foreign competition on job losses. Moreover, the hybrid model features general equilibrium effects between these two types of goods as markups vary.

There are no fixed costs of entry or operation. Each firm  $\varphi$  is exogenously assigned its type  $\nu(\varphi) \in \{H, M\}$  and its productivity  $z(\varphi) \in Z$ . Each differentiated good firm operates a linear production technology that uses labor as the only input:

$$y(\varphi) = z(\varphi) \cdot \ell$$

where  $\ell$  is the labor input. The productivity  $z(\varphi)$  is drawn randomly and follows a Pareto distribution with lower bound  $A \equiv 1$  and shape parameter  $s$ . Finally, each  $H$ -type (head-to-head) producer has a randomly drawn head-to-head competitor.

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<sup>11</sup>This however does not shutdown the effect of the relative number of varieties of each type. See [Blanchard and Giavazzi \[2003\]](#) and [Benassy \[1996\]](#) for related discussions.

<sup>12</sup>The combination of both monopolistic competition and head-to-head competition resembles the model of *mass production plants* and *boutique shops* used by [Holmes and Stevens \[2010\]](#) in their study of plant size distribution with an application the trade in wood furniture. In this paper, I do not assume monopolistic firms are smaller or that they do not export. Also [Freeman and Kleiner \[2005\]](#) show in their study of the “last American manufacturers” that product differentiation and industrial relations are additional channels of adjustment. Strategic product differentiation will make  $M/H$  endogenous. Adding this choice did not significantly alter the main results when the differentiation costs are proportional to monopoly profits.



The firms in the homogeneous good sector are homogeneous, compete perfectly and have a simple linear technology:

$$y_0 = \ell$$

I assume there are symmetric international iceberg transportation costs  $\tau \geq 1$ .

## Segmented Local Labor Markets

The economy is composed of a continuum of local labor markets across which families assign their workers. Within each local labor market, workers are randomly matched with vacancies based on a Leontief matching function: firms fill all their vacancies if there are more workers looking for jobs than vacancies. This aspect of the model’s labor market structure is similar to [Alvarez and Shimer \[2010\]](#) in the sense that there is directed search across labor markets and random search within local labor markets.

I assume that, in each country, there are many H-type (head-to-head) towns and many M-type (monopolist) towns, in addition to the homogeneous towns. The main goal in defining locations in this model is to have variations in the extent of foreign competition. I define a local labor market as a collection of towns with the same productivity level ( $z$ ) and the same type (M or H). In other words, firms do not choose the locations where they operate. Within each local labor market, firms differ in the productivity of the foreign firms they face. The common productivity assumption is key to get varying degrees of foreign competition across local labor markets<sup>13</sup>. [Figure 4 on the following page](#) provides an illustration of differences across and within locations.

At each plant<sup>14</sup>, the workers bargain collectively with the firm over wages and production decisions. The workers collectively have bargaining power  $\lambda$ . Unlike [Felbermayr et al. \[2010\]](#) and [Helpman and Itskhoki \[2010\]](#), I simply assume Nash-bargaining and not the multilateral bargaining approach proposed by [Stole and Zwiebel \[1996\]](#)<sup>15</sup>. Firms have to pay a hiring cost  $\gamma$  per hire<sup>16</sup>. The union’s threat point is defined by a home production technology yielding

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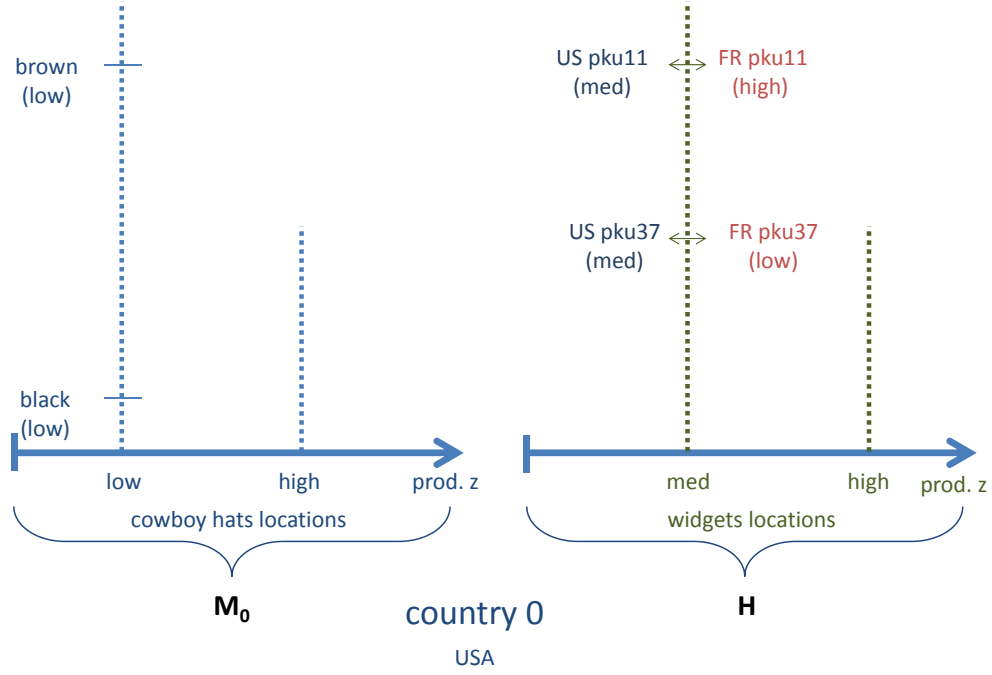
<sup>13</sup>The stark assumption on common productivity within a location is simply made to highlight the channel of foreign competition I introduce. At the opposite extreme, if all locations did not vary in productivity, the model would be unable to address the unemployment effects of trade across locations.

<sup>14</sup>Given the export decisions of the firms, in each town, there could be one or two plants: the domestic production plant if the local firm produces for the domestic market and the foreign production plant if the local firm exports. This distinction is a useful simplification because the productivity of the firm is effectively reduced by iceberg transportation costs when it produces for the export market: it takes more labor to produce one unit of output sellable abroad since the product “melts” on the way.

<sup>15</sup>Nash-bargaining provides a simple and tractable baseline to highlight how unemployment is determined. In this model, variable markups are a key feature for the distribution of unemployment as shown later. This feature is absent in [Felbermayr et al. \[2010\]](#) and [Helpman and Itskhoki \[2010\]](#).

<sup>16</sup>Since the matching follows a Leontief function, there are no congestion externalities in this model.

Figure 4: A simple illustration of locations



$b \geq 1$  units of the numeraire good. The homogeneous sector is not subject to any hiring and matching frictions.

## 4.2 Characterization

### M-type (Monopolist) Firm Problem

Consider the decision of a monopolist firm in country  $j$  with productivity  $z$  that is supplying country  $j'$ . With  $\ell_{j'}^j$  workers, the firm-union match generates the following surplus:

$$S_{j'}^j(z, \ell_{j'}^j) = \underbrace{Q_{j'}^{-(\rho-\eta)} \left( \frac{1}{\tau_{j'}^j} z \ell_{j'}^j \right)^{\frac{1}{\mu}}}_{R_{j'}^j(z, \ell_{j'}^j)} - b \ell_{j'}^j - \gamma \ell_{j'}^j$$

since the price implied from the demand function is:

$$p_{j'}^j(z, \ell_{j'}^j) = Q_{j'}^{-(\rho-\eta)} \left( \frac{1}{\tau_{j'}^j} z \ell_{j'}^j \right)^{-\frac{1}{\sigma}}$$

The firm's profit from this plant is:

$$\pi_{j'}^j(z, \ell_{j'}^j) = R_{j'}^j(z, \ell_{j'}^j) - \gamma \ell_{j'}^j - \omega_{j'}^j(z) \ell_{j'}^j$$

where  $\omega_{j'}^j(z)$  is the wage paid to the workers.

The wages  $\omega_{j'}^j(z)$  and the plant size  $\ell_{j'}^j$  are determined through Nash-bargaining with the workers' union<sup>17</sup>:

$$\max_{\omega, \ell} \left[ Q_{j'}^{-(\rho-\eta)} \left( \frac{1}{\tau_{j'}^j} z \ell \right)^{\frac{1}{\mu}} - \gamma \ell - \omega(z) \ell \right]^{1-\lambda} \cdot [(\omega - b) \ell]^\lambda$$

Since all costs are variables, the firm and the union choose to share revenues according to their bargaining power and set:

$$p_{j'}^j(c) = \mu \tau_{j'}^j c \quad \text{price}$$

$$\omega_{j'}^j(c) - b = \lambda (\mu - 1) (\gamma + b) \equiv \omega_M - b \quad \text{wage}$$

$$\ell_{j'}^j(c) = Q_{j'}^{-\frac{\rho-\eta}{1-\rho}} \left[ \mu (\gamma + b) \right]^{-\sigma} \left[ \frac{(\gamma + b)}{\tau_{j'}^j c} \right]^{\sigma-1} \equiv \mu^{-\sigma} \bar{\ell}_{j'}^j(c) \quad \text{size}$$

where  $\tau_{j'}^j c \equiv \tau_{j'}^j \frac{(\gamma + b)}{z}$  is the firm's unit cost and  $\bar{\ell}_{j'}^j(c)$  is the size corresponding to the marginal cost pricing (zero profits).

The **M**-type (monopolist) producers therefore choose the standard markup pricing rule that equalizes the marginal revenue and the marginal cost. Although more productive firms are larger, it is important to note that the wages are independent of the firm productivity for the monopolistic firms. This is a standard result in environments with power revenue functions and linear technology. This property that wages do not depend on firm productivity is the main reason why **M**-type (monopolist) towns have a degenerate distribution of wages and unemployment rate. [Felbermayr et al. \[2010\]](#) and [Helpman and Itskhoki \[2010\]](#) also have the same result. In the next subsection, I show how variable markups induced by head-to-head competition crucially change these results.

The surplus extracted by a worker is a fraction of the average gross revenues of the firm: each worker receives a share  $\lambda$  of the net markup  $(\mu - 1)$ . Also, since there are no fixed cost of exporting, all **M**-type producers export.

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<sup>17</sup>The problem of the monopolist is cast in terms of size ( $\ell$ ) and not prices but the two formulations are equivalent given the bijection between price and quantities.

Finally, given the random Leontief matching assumed, the local labor market of an  $\mathbf{M}$ -type producer with productivity  $z$  has an employment rate  $\mathbf{e}_{\mathbf{M}}(z)$  :

$$\mathbf{e}_{\mathbf{M}}(z) = \frac{\sum_{j'=0,1} \ell_{j'}^j(z)}{\mathbf{L}_{\mathbf{M}}(z)}$$

where  $\mathbf{L}_{\mathbf{M}}(z)$  is the endogenous population of workers available in that town. The expected earnings per worker  $\mathbf{W}_{\mathbf{M}}(z)$  in the town of an  $\mathbf{M}$ -type producer with productivity  $z$  therefore satisfy:

$$\mathbf{W}_{\mathbf{M}}(z) - b = (\omega_{\mathbf{M}} - b) \cdot \mathbf{e}_{\mathbf{M}}(z)$$

### **H-type (Head-to-head) Firm Problem**

The problem of the  $\mathbf{H}$ -type (head-to-head) producers can be similarly characterized. Each type producer makes its production decision knowing its productivity and the productivity of its head-to-head foreign competitor. The problem faced by the  $\mathbf{H}$ -type firm is a constrained version of the  $\mathbf{M}$ -type firm's problem. The constraint here is that its price has to be above the price that makes the competitor's profits equal zero. This is effectively a constraint on the firm's ability to reduce output by charging the unconstrained monopolistic price.

The constrained problem faced by the  $\mathbf{H}$ -type (head-to-head) producers can therefore be written as a problem similar to the  $\mathbf{M}$ -type (monopolistic) producer problem with an upper bound on the price set by the firm:

$$\begin{aligned} \max_{\omega, \ell} \quad & \left[ \mathbf{Q}_{j'}^{-(\rho-\eta)} \left( \frac{1}{\tau_{j'}^j} z \ell \right)^{\frac{1}{\mu}} - \gamma \ell - \omega(z) \ell \right]^{1-\lambda} \cdot [(\omega - b) \ell]^\lambda \\ \text{s.t.} \quad & p_{j'}^j(z, \ell) \leq \bar{p}_{j'}^{1-j}(\tilde{z}) \\ & \pi_{j'}^j(z, \ell) \geq 0 \end{aligned}$$

where  $\bar{p}_{j'}^{1-j}(\tilde{z})$  is the marginal cost to supply country  $j$  for the foreign competitor whose productivity is  $\tilde{z}$ .

The upper bound on the price is precisely the constraint on a firm's ability to restrict output. This bound only depends on the competitor's productivity. Specifically, when an  $\mathbf{H}$ -type (head-to-head) producer from country  $j$  with productivity  $z$  is matched with a foreign competitor with productivity  $\tilde{z}$ , the  $\mathbf{H}$ -type producer from country  $j$  supplies a country  $j'$  in its variety if and only if:

$$\tau_{j'}^j \frac{(\gamma + b)}{z} < \tau_{j'}^j \frac{(\gamma + b)}{\tilde{z}}$$

since the unit cost of for the firm-union entity is  $\tau_{j'}^j \frac{(\gamma + b)}{z} \equiv \tau_{j'}^j c$ .

It is convenient to interchangeably and without loss of generality identify a firm  $z$  by its unit cost:  $c \equiv \frac{(\gamma + b)}{z}$ . Conditional on supplying the market  $j'$ , the producer may either be at the corner (constrained) or choose the unconstrained monopolistic pricing:

$$p_{j'}^j(c, \tilde{c}) = \underbrace{\min \{ \tau_{j'}^{1-j} \tilde{c} , \mu \tau_{j'}^j c \}}_{\mu_{j'}^j(c, \tilde{c}) \times \tau_{j'}^j c} \quad \text{price}$$

which implies that:

$$\omega_{j'}^j(c, \tilde{c}) - b = \lambda (\mu_{j'}^j(c, \tilde{c}) - 1) (\gamma + b) \quad \text{wage}$$

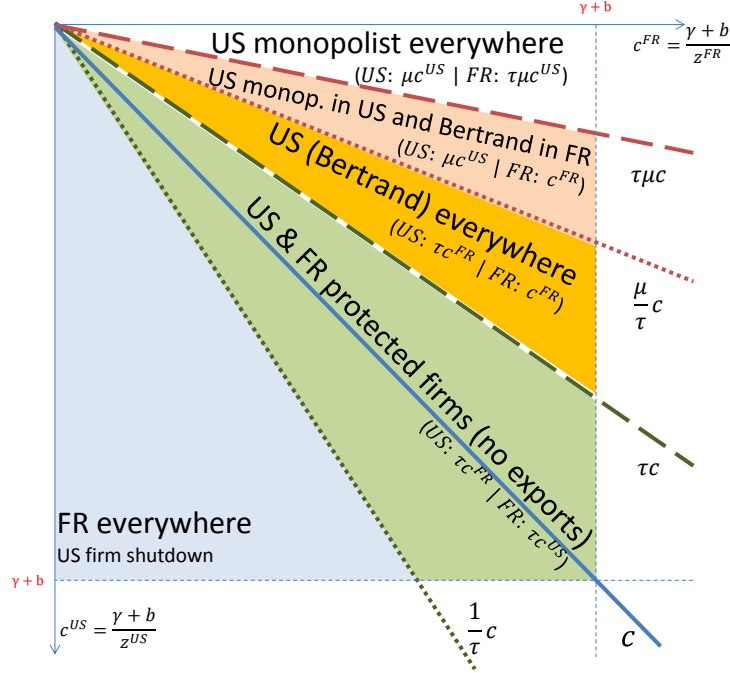
$$\begin{aligned} \ell_{j'}^j(c, \tilde{c}) &= Q_{j'}^{-\frac{\rho-\eta}{1-\rho}} \left[ \mu_{j'}^j(c, \tilde{c}) (\gamma + b) \right]^{-\sigma} \left( \frac{1}{\tau_{j'}^j} \frac{\gamma + b}{c} \right)^{\sigma-1} \quad \text{size} \\ &= \left[ \mu_{j'}^j(c, \tilde{c}) \right]^{-\sigma} \bar{\ell}_{j'}^j(c) \end{aligned}$$

Therefore, the profit margin of the H-type (head-to-head) producer is more squeezed the more productive its competitor is. This is associated with lower wages for those workers as well because of the surplus sharing rule. The effect of the head-to-head competition on the firm behavior also depends on the level of frictions to international trade. In fact, as the tariff  $\tau$  goes to infinity (autarky), the H-type producers are all in operation and they all charge the unconstrained monopolistic price:  $\lim_{\tau \rightarrow \infty} \mu_{j'}^j(c, \tilde{c}) = \mu$ . On the other hand, when trade is frictionless, only some firms charge the monopolistic price. The model generates rich pricing dynamics as shown in the illustration in [Figure 5 on the next page](#).

These variable markups are also the reason why productivity differences yield differences in foreign competition across locations: in the more productive locations, more firms out-compete their foreign competitors relative to the less productive locations. Also, the relative size of trade tariffs and markups are also important to predict the elasticity of trade. For instance, a careful inspection of [Figure 5 on the following page](#) shows that when  $\mu < \tau^2$ , some tariff-protected firms price as monopolists even if they do not export. The model also generates a region of international dumping that only disappears in the limit of frictionless trade when  $\tau = 1$ .

Based on these results, a town of H-type (head-to-head) producers with productivity  $z$  has an unemployment rate  $\mathbf{e}_H(z)$  satisfying:

Figure 5: Variable markups illustrated



$$e_H(z) = \frac{\int \sum_{j'=0,1} \ell_{j'}^j(z, \tilde{z}) dF_H(\tilde{z})}{L_H(z)}$$

where  $L_H(z)$  is the endogenous population of workers available in that town and  $\ell_{j'}^j(z, \tilde{z}) = 0$  if a local producer does not supply country  $j'$  due to the competition. The expected earnings per worker  $W_H(z)$  in that town therefore satisfy:

$$W_H(z) - b = \frac{\int \sum_{j'=0,1} (\omega_{j'}^j(z, \tilde{z}) - b) \cdot \ell_{j'}^j(z, \tilde{z}) dF_H(\tilde{z})}{L_H(z)}$$

## Labor Allocation

Each family<sup>18</sup> allocating its workers across locations is indifferent among these locations since the workers are *ex ante* mobile. Workers are allocated knowing the tariff, the town's competition type (monopolistic or head-to-head competition), and the productivity of the firms in these locations. Therefore, each worker knows the distribution of wages and unemployment

<sup>18</sup>As in [Helpman and Itskhoki \[2010\]](#), the family interpretation is essential in the case of quasi-linear preferences but not when preferences are homothetic.

rates across towns. Each family therefore chooses  $\{L_0, L_M(z), L_H(z) : z \in Z\}$  such that:

$$L = L_0 + \int L_M(z) dF_M(z) + \int L_H(z) dF_H(z)$$

In a symmetric equilibrium, the allocation of labor is an interior point if and only if they are indifferent across the towns. In other words, expected earnings are equalized across towns:

$$\omega_0 = W_M(z) = W_H(z) \quad \forall z \mid L_K(z) > 0$$

where  $\omega_0 = p_0 = 1$  is the wage in the frictionless homogeneous region. The indifference condition simplifies to an equality in expected earnings because the preferences are quasi-linear.

### Market Clearing

The market clearing condition for the homogeneous good is:

$$L_0 = q_0 + \gamma \cdot \left( \int \sum_{j'=0,1} \ell_{j'}^j(z) dF_M(z) + \iint \sum_{j'=0,1} \ell_{j'}^j(z, \tilde{z}) dF_H(\tilde{z}) dF_H(z) \right)$$

since the hiring costs are paid in units of the homogeneous good.

### 4.3 Equilibrium

Having characterized the problem and the optimal decision of the agents in the economy, a symmetric equilibrium is:

- a price  $P$ ,
- quantities  $q_0$  and  $Q$ ,
- population allocations  $\{L_0, L_M(z), L_H(z) : z \in Z\}$ ,
- earnings  $W$ , and
- aggregate profits  $\pi$

such that:

- households solve their utility maximization given prices and profits and earnings.
- the indifference condition across towns for labor allocation holds,

- firms producing the differentiated goods solve their profit maximization problem given their productivity, their competition, and the aggregate consumption indexes.
- aggregate profits, aggregate earnings, and the price index are consistent with the firm decisions.
- all goods markets clear.

## 4.4 Wages, Unemployment, and Geographic Inequality

This model is quite simple and tractable. Most importantly, the model incorporates standard gains from trade in addition to unemployment in segmented labor markets facing different levels of foreign competition. The following important properties hold in equilibrium:

**Proposition 1.** Equal expected earnings.

*Expected earnings are equalized across all labor markets. When all workers have an equal share in all the firms within an economy, average income is also equalized across labor markets.*

*Proof.* The proof trivially follows from the labor allocation rule characterized. Given the quasi-linear preferences, in equilibrium, expected earnings (job finding rate multiplied by wages) are equalized across labor markets.  $\square$

In light of this proposition, greater vulnerability to foreign competition does not mean labor market outcomes are necessarily worse in those locations. Unemployment is actually lower in the most vulnerable towns because they pay lower wages and attract fewer workers. However, unexpected trade reforms unevenly change the expected level of foreign competition faced by different labor markets. The most vulnerable labor markets can be wiped out following a trade reform and the distribution of expected earnings is no longer degenerate. This is shown and discussed in the next section.

**Proposition 2.** Constant unemployment across location with no foreign competition.

*Across the labor markets where the firms are all monopolistic competitors, the more productive labor markets have higher employment but they pay the same wage and have the same unemployment rate as less productive labor markets.*

*Proof.* The proof trivially follows from the fact that markups are constant across all M-type (monopolist) firms and that expected earnings are equalized because of the directed search.  $\square$



This proposition is important because it shows why, in this model, head-to-head competition is key for a non-degenerate distribution of unemployment across labor markets. In the absence of head-to-head competition, the distribution of unemployment rate is degenerate because wages would be independent of firm productivity. Consequently, the wage determination rule assumed in this model is not an innocuous assumption. However, the abstraction from multilateral bargaining is not problematic since the constant wage result also holds in [Helpman and Itskhoki \[2010\]](#) and [Felbermayr et al. \[2010\]](#).

**Proposition 3.** Unemployment profile across locations facing foreign competition.

*Across the labor markets where the firms face foreign competitors, when there are no trade barriers, the more productive labor markets have higher employment, pay higher wages and have higher unemployment rate than less productive labor markets.*

*Proof.* The proof follows from the fact the expected markups and wages of H-type (head-to-head) firms increase with their productivity.  $\square$

This proposition only holds in the absence of trade barriers because trade barriers alter the distribution of markups as illustrated in [Figure 5 on page 22](#). For instance, if trade barriers are high enough, non exporters charge the same markup as the most productive firms while some exporters charge a lower markup because of foreign competition. In that case, the unemployment rate is not decreasing with productivity. In general, the non monotonicity of unemployment rate holds as illustrated in [Figure 6](#), except in the extreme cases of autarky and frictionless trade.

## 4.5 Equilibrium Labor Allocations

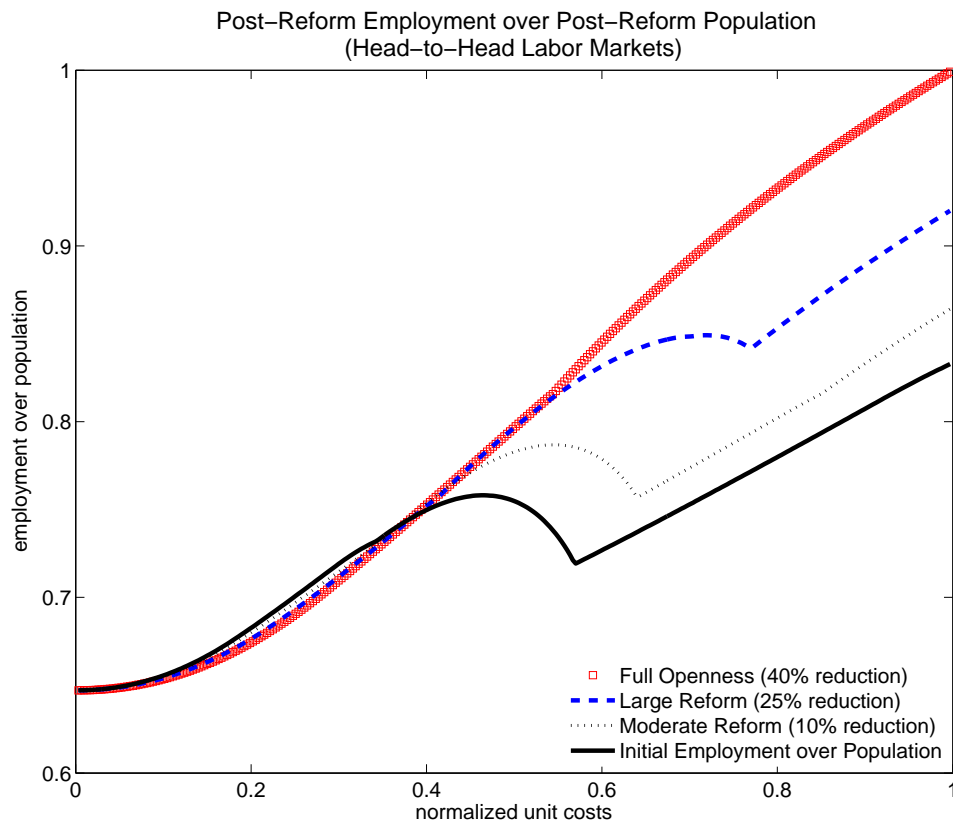
To illustrate the distribution of unemployment, [Figure 6 on the following page](#) shows the equilibrium<sup>19</sup> employment-to-population in head-to-head labor markets ordered by the unit cost of their local firms (inversely proportional to productivity) for different levels of iceberg transportation trade costs. The initial level of iceberg transportation costs used in this illustration is arbitrarily set to  $\tau = 1.75$ .

The hump in the unemployment profile that occurs around medium size locations only disappears in the limit of frictionless trade. Also, there is a kink at the productivity level where firms produce but not export. This is a result of the distribution of variable markups illustrated in [Figure 5 on page 22](#). Higher markups mean higher wages which typically more employment levels but also lower employment rates. At the kink, the infra-marginal

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<sup>19</sup>While the model is quite simple and tractable in terms of individual optimization, the equilibrium has to be numerically computed because the double integrals involved do not yield nice closed form solutions.

Figure 6: Trade Barriers and Labor Allocation



location that exports has higher employment rate because markups and therefore wages fall slightly due to iceberg transportation costs. The effect of the iceberg transportation costs on exporting firms explains the observed kink. The observed hump is therefore a normal artifact since the markups are bounded. Also, in autarky, the employment-to-population ratio is constant at the employment rate of the most productive labor market: in the most productive labor markets, firms almost surely outcompete their foreign rivals and behave as monopolists.

## 5 Effects of an Unexpected Trade Liberalization

The model incorporated new ingredients to deliver a simple theory of local unemployment and import competition. In the remainder of the paper, I discuss the unemployment effects of an unexpected trade liberalization in the U.S. These effects are then contrasted with the

effects of an unexpected productivity increase in foreign productivity. Following, [Helpman and Itskhoki \[2010\]](#), I assume the workers are *ex ante* identical and mobile across labor markets but *ex post* immobile across labor markets. Specifically, the *ex post* mobility assumption means workers do not move across local labor market following an unexpected trade reform. However, workers can switch jobs within their location. This limited mobility assumption captures the very slow adjustments of the total population to adverse trade shocks documented in [Autor, Dorn, and Hanson \[2011\]](#) and in this paper. [Topalova \[2007\]](#) also has similar findings using data on districts in India following a trade liberalization.

First, the model can replicate the correlated effects of increased import competition both job losses and job gains. In other words, layoffs and plant shutdowns are only one symptom of foreign competition. The locations that face tougher foreign competition and lay off more workers are precisely less productive. This also implications for the new jobs they create relative to other locations: less productive locations create fewer new export-driven jobs. Second, the model predicts aggregate welfare gains following an unexpected trade liberalization despite the large job losses and the high unemployment in the worse hits locations. Third, an unexpected foreign productivity increase can, in contrast, yield aggregate welfare losses.

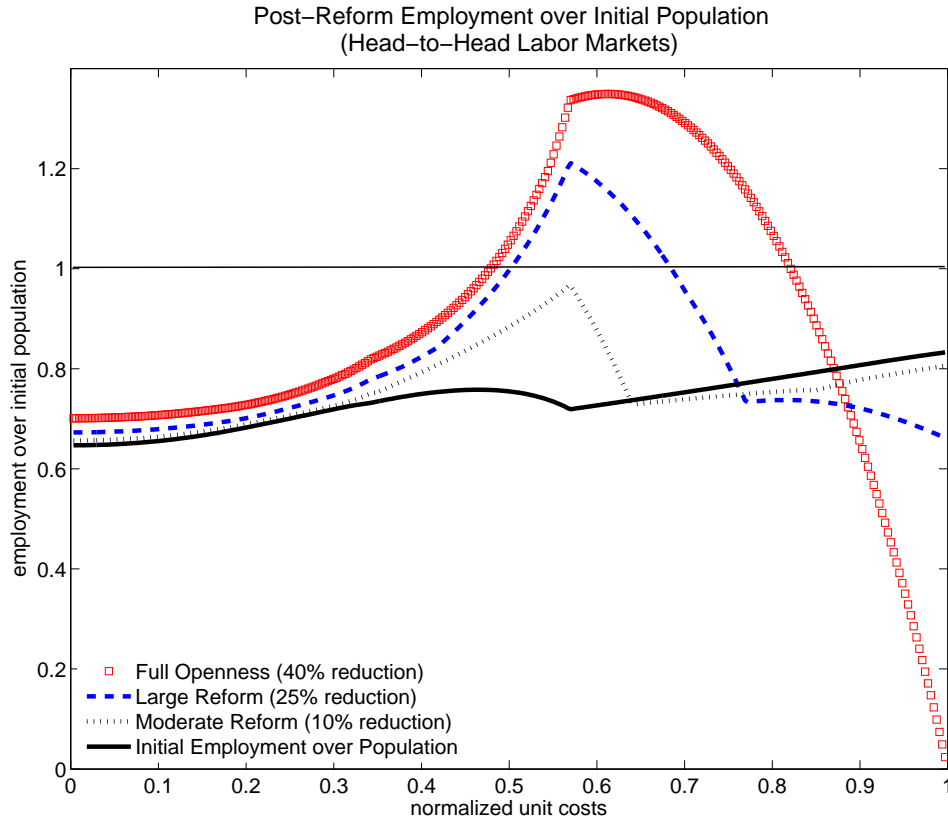
Below, I motivate and define the concept of medium run equilibrium before discussing the model calibration and the welfare gains from an unexpected trade liberalization and the effects of an exogenous productivity growth in the foreign country.

## 5.1 Medium Run Equilibrium

When trade barriers unexpectedly fall, it asymmetrically affects firms and labor markets: some labor markets expand as their firms newly gain access to foreign markets, some labor markets are wiped out as most of their firms are out-competed, and some labor markets expand as their pressured firms slash domestic prices while workers can only move within but not across local labor markets. With large reductions in trade barriers, the size adjustments induced by lower prices can be very large, and even exhaust the pre-reform population (see an example in [Figure 7 on the following page](#)). On the other hand, modest tariffs reforms require modest size adjustments (see an example in [Figure 7 on the next page](#)).

Therefore, the equilibrium allocation of an economy following a trade reform depends on the preexisting unemployment rates in the local labor markets where firms need to expand. In this model, the largest (proportional) firm expansions typically occur in the medium-sized firms that are new exporters. This is reflected in the kink at the export cutoff level shown in [Figure 7 on the following page](#): the largest expansion occurs in the infra-marginal exporting

Figure 7: Limits to Long Run Reallocation of Labor



location.

Given the employment capacity constraints that firms may face in the wake of trade reforms, the aggregate firm behavior needs to be consistent with the population bounds in each location. This is a problem that does not exist in the long-run equilibrium in which all labor markets have a positive unemployment rate.

A notion of equilibrium coherent with the limited mobility is needed. I define the *medium-run equilibrium* as an equilibrium concept similar to the long-run equilibrium, except that families do not have a labor allocation problem. In other words, the population levels in the segmented local labor markets are fixed to the levels prior to the unexpected fall in trade barriers. These constraints effectively reduce the quantity of differentiated good supplied in the *medium-run* compared to the long run<sup>20</sup>. To compute the *medium-run equilibrium* outcome, I define and characterize the workforce-constrained firm problems. For simplicity,

<sup>20</sup>However, it does not mean that welfare gains are necessarily lower compared to the long run. This is because there is an allocative inefficiency when workers are mobile across locations.

I assume that firms that operate in labor markets that are constrained simply produce as much as they can<sup>21</sup>.

Given an initial population allocation  $\{L_0, L_M(z), L_H(z) : z \in Z\}$ , a symmetric *medium run equilibrium* is:

- a price index  $\widehat{P}$ ,
- quantities  $\widehat{q}_0$  and  $\widehat{Q}$ ,
- earnings  $\widehat{W}$ , and
- aggregate profits  $\widehat{\pi}$

such that:

- households solve their utility maximization given prices and profits and earnings.
- firms solve their profit maximization problem given their productivity, their competition, the aggregate consumption indexes, and the local population
- aggregate profits, aggregate earnings, and the price index are consistent with the firm decisions.
- all goods markets clear.

## 5.2 Medium Run Labor Market Outcomes

To illustrate the effect of trade reforms on labor market adjustments, I show in Figure 8 on the next page the medium run distribution of labor in head-to-head labor markets compared the initial allocations and the long run distribution when workers move across labor markets<sup>22</sup>.

Figure 8 on the following page shows the uneven labor market adjustments that occur across head-to-head local labor markets ordered by unit costs (inversely proportional to productivity). As before, the monopolist labor markets have a degenerate distribution at the level of the most productive head-to-head labor markets. The equilibrium concept defined above ensures that the aggregate demand is consistent with the decisions of the firms operating in the labor markets that are population constrained.

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<sup>21</sup>In earlier version of the paper, I considered the case when the firms seek to equalize the marginal surplus across domestic and foreign production when they are capacity constrained. It does not fundamentally alter the results but introduces more discontinuities in the employment rate without adding any important insight. This is the main reason behind the simplification made here.

<sup>22</sup>Obviously, worker immobility following the trade reform is also a crucial assumption because it ensures local job losses induce local unemployment. Otherwise, workers would move to towns with better prospects leaving ghost towns behind. The assumption made on worker relocation is however consistent with empirical findings on the lack of population response to trade shocks in the short-run.

Figure 8: Medium Run Reallocation of Labor

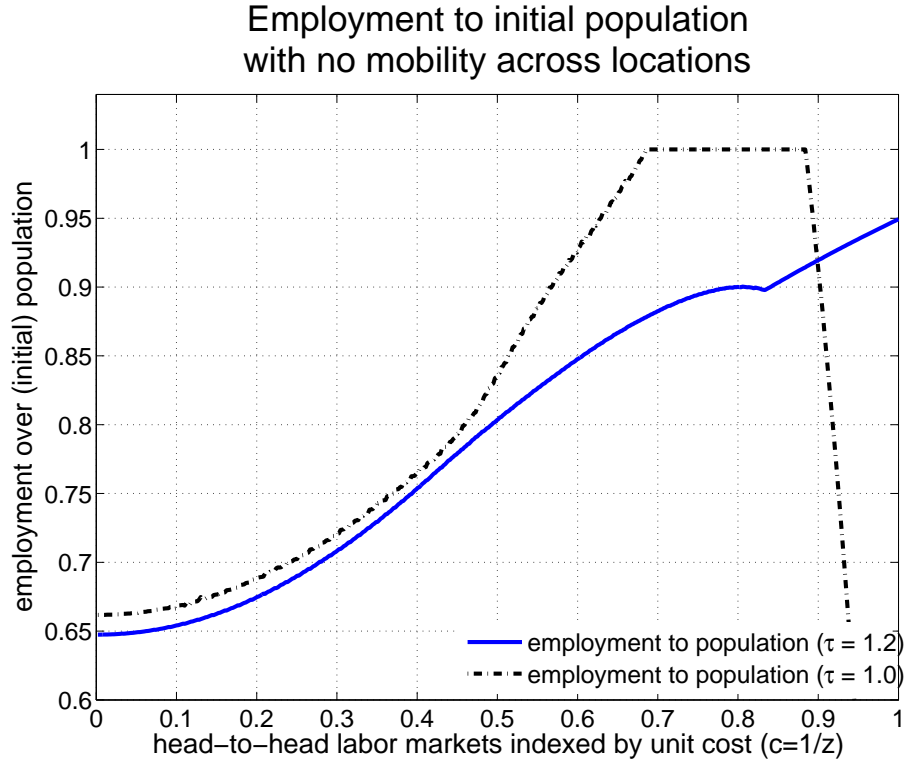


Figure 8 also illustrates that some labor markets do not expand as much as they would if labor were fully mobile. These firms however still expand a lot while the least productive labor markets shrink. In fact, the least productive labor markets lose all their firms since all of them are out-competed in the absence of trade barriers.

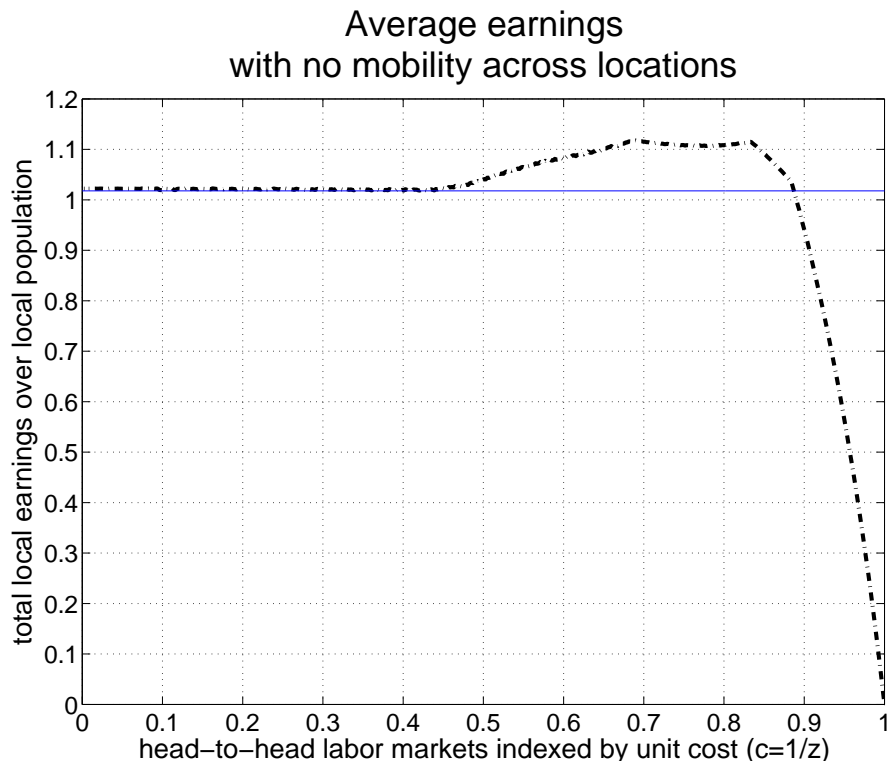
As trade barriers fall, the firms in the marginal exporting labor markets are able to outcompete their foreign rivals in foreign markets, and thereby expand a lot. This extensive margin explains the largest expansions. In comparison, some less productive head-to-head labor markets lose most of their firms because they are out-competed. At the other extreme, the most productive head-to-head labor markets are hardly affected by the fall in trade barriers as they behave as monopolists and have almost no new exporters.

Overall employment changes depend on both job losses due to increased foreign competition and job creation. The correlation is driven in the model by the fact that local labor markets differ in productivity.

The combined effects of changes in employment and changes in wages are reflected in Figure 9 on the following page which shows the expected earnings in each head-to-head labor market in the *medium run*. While full labor mobility ensured wages were equalized across labor markets, limited mobility induces a non-degenerate distribution of expected earnings.

This earnings inequality is a source of income redistribution across labor markets if consumption is equalized across labor markets. It is important to note that no redistribution across labor markets was needed under full worker mobility to equalize income. Redistribution was not required because of the indifference condition across locations. This condition no longer holds in the *medium run* as shown in Figure 9.

Figure 9: Medium Run Earnings Differentials



### 5.3 Calibration

In this section, I calibrate the model to measure the effects of a trade liberalization in the U.S. across labor markets. The overall parameters used in the unexpected trade liberalization exercise are summarized in Table 3 on the following page.

The Armington elasticity is also crucial for the differential effects across labor markets since the labor markets vary in productivity and therefore average producer prices. The Armington elasticity choice follows the Armington elasticity of substitution found by Ruhl [2004]. The iceberg transportation cost is set below the trade costs including observed tariffs and non-tariff barriers in rich countries documented in Anderson and van Wincoop [2004]. The Pareto distribution shape parameter is set to be greater than 2.05 to guarantee finite

mean and finite variance. The bargaining power is set to 0.5 so the union and the firm have equal bargaining power.

The fraction of firms subject to head-to-head foreign competition is chosen so that the total number of trade-induced displacements in the U.S. matches the level we see in the data.

The outside option parameter is chosen so that all local labor markets receive attract workers under full worker mobility. The parameters are set to have a non-employment rate around 30 percent.

Table 3: Calibration

| Parameter | Description                                       | Value |
|-----------|---|-------|
| H         | Fraction of head-to-head firms                    | 0.03  |
| M         | Fraction of monopolist firms                      | 0.97  |
| $\sigma$  | Armington elasticity                              | 2.01  |
| $\eta$    | Elasticity of substitution of differentiated good | 0.50  |
| $s$       | Pareto distribution shape                         | 2.05  |
| $\lambda$ | Union bargaining power                            | 0.50  |
| $b$       | Outside option                                    | 1.00  |
| $\gamma$  | Hiring cost                                       | 0.15  |
| L         | Population  | 1.00  |
| $\tau_0$  | Iceberg transportation costs pre-liberalization   | 1.20  |
| $\tau_1$  | Iceberg transportation costs post-liberalization  | 1.00  |

## 5.4 Foreign Competition and Nonemployment

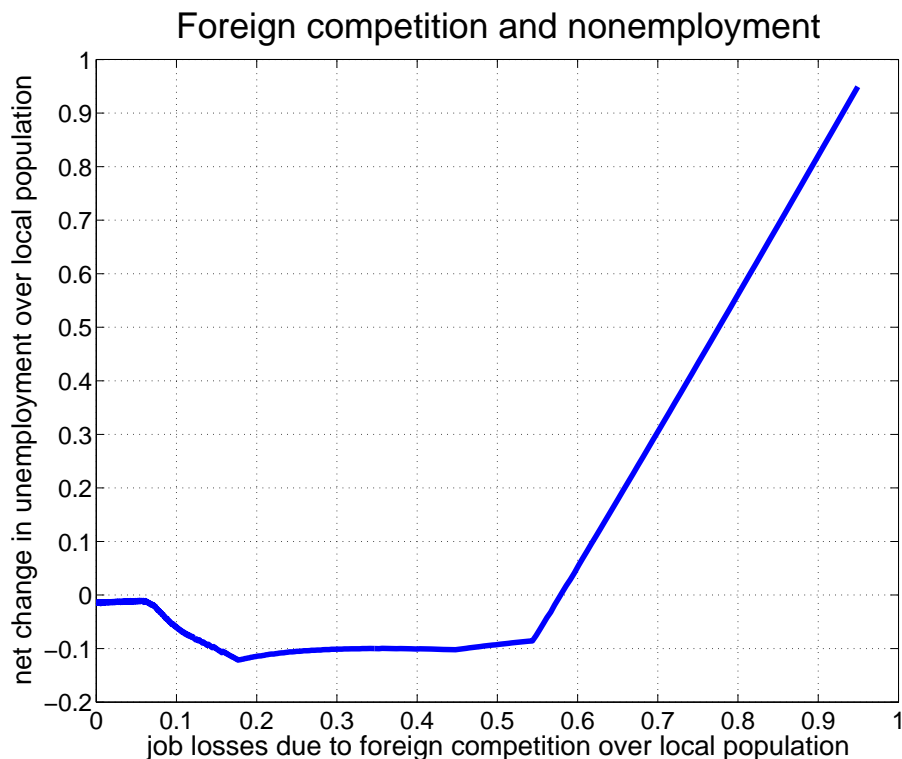
To relate the model to the empirical findings, I now measure the import competition faced by a labor market using a statistic akin to Trade Adjustment Assistance (TAA) certifications observed in the data: the number of workers in a given labor market that are displaced because of foreign competition.

In particular, I measure local import competition in the model as the fraction of local workers who lost their jobs after their plant shut down due to head-to-head competition. This measure is equal to zero in non head-to-head labor markets. It is also equal to zero in the absence of trade reforms since workers are not employed at out-competed firms in the first place. It is important to note that without head-to-head competition, this measure would not be meaningful. In the standard [Melitz \[2003\]](#) model and similar models with no direct competition, a TAA-measure of import competition would always be zero because the firms do not shut down because of direct foreign competition. TAA investigators would not find evidence for the foreign competition as a cause of the layoffs.



Figure 10 illustrates the relationship between the measure of TAA-certified workers and unemployment changes in the model. First, net changes in unemployment may be positive or negative depending on the productivity of the head-to-head labor markets. As indicated earlier, the non head-to-head labor markets correspond to a degenerate distribution at the point where trade-induced job losses are zero. Second, the job creation margin explains the increased steepness of the curve in the locations experiencing the largest job losses due to import competition. Third, it is easy to observe that the elasticity of local non-employment to local job losses due to import competition is close to three in the worst hit locations. This differential effect is explained by the correlation between lower productivity and vulnerability to import competition.

Figure 10: Foreign Competition and Nonemployment



However, this relationship is non monotonic. This is due to the heterogeneity in markups discussed in the previous section. This last feature does not show in the data although a Pareto distribution of firm productivity skews the unit cost distribution to the right. Also, in a given labor market, the overall job losses are equal to job losses to foreign competition since the model does not have any local input-output linkage mechanism such as the local burger stand closing down<sup>23</sup>.

<sup>23</sup>I did not find any significant empirical effect of foreign competition on housing starts.

## 5.5 Welfare Gains and Limited Worker Mobility

Both the model and the data indicate that import competition has large uneven effects on labor markets through job losses but also job gains: there are large differential of foreign competition on earnings across locations. Clearly, without transfers, some locations are worse off as they see their employment and earnings drop.

However, the model predicts overall aggregate welfare gains and increased aggregate employment in the medium run despite with the large differential impact of import competition on unemployment and earnings across the few local labor markets subject to head-to-head foreign competition. The aggregate welfare effects are summarized in Table 4.

Table 4: Effects of Limited Mobility

|            | Trade job losses<br>(per 1,000 w.a.p.) | Not employed<br>(percent) | % $\Delta Q$<br>(diff. goods) | % $\Delta q_0$<br>(hom. good) | % $\Delta U$<br>(utility) |
|------------|--|---------------------------|-------------------------------|-------------------------------|---------------------------|
| Pre-reform | 0.00                                   | 27.86                     | -                             | -                             | -                         |
| Medium run | 1.4                                    | 27.32                     | +5.20                         | -0.33                         | +0.99                     |
| Long run   | 0.00                                   | 28.14                     | +5.21                         | -5.89                         | +0.85                     |

These welfare gains are actually not smaller than the gains when labor is fully mobile. While the differentiated good demand is indeed however lower, the limited mobility reduces the inefficiencies from search frictions by increasing the overall employment level. This finding is in contrast with the results found in models of unemployment and trade such as [Cosar \[2010\]](#), [Dix-Carneiro \[2010\]](#) and [Kambourov \[2009\]](#) where limited sectoral mobility necessarily reduces the overall gains from trade. In this model, the main source of unemployment of the inefficiency from the directed search as opposed to matching frictions. Limited mobility can partially undo that inefficiency.

## 5.6 Trade Reforms and Exogenous Growth : Similar Effects?

The sustained and balanced growth in U.S. imports as a share of its gross domestic product may indicate a fall in trade barriers or a growth in foreign foreign productivity. For instance, [Autor et al. \[2011\]](#) argue that the adverse labor market effects of import competition from China are due to an exogenous growth in China. In this subsection, I compare the effects an unexpected trade reform and an exogenous foreign productivity growth.

In contrast to the aggregate welfare gains obtained in the wake of a trade reform, the aggregate welfare effects are negative in the advanced economy in the case of an asymmetric setup with foreign exogenous growth instead of the current case of an exogenous fall in trade

barriers. The intuition is that all domestic labor markets, including the most productive ones, lose jobs due to the surge foreign competition (see Figure 11).

Figure 11: Foreign Competition and Unemployment with Exogenous Growth

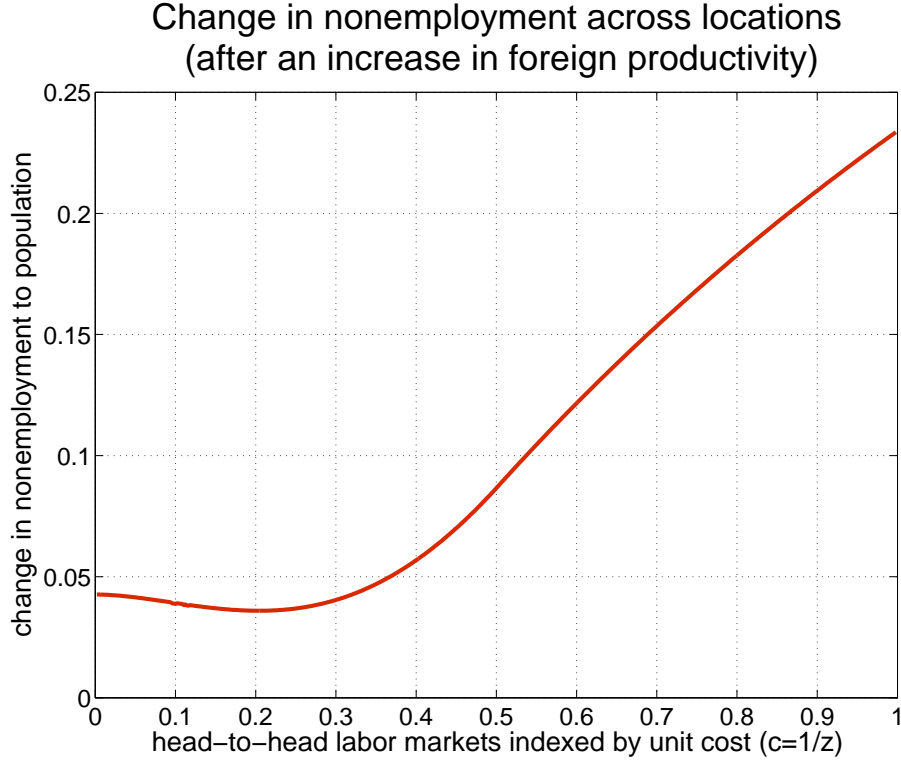


Figure 11 illustrates the net changes in unemployment across head-to-head labor markets when the foreign country experiences an exogenous growth in productivity<sup>24</sup> in the absence of trade barriers. However, it is worth noting that this exogenous growth case alone cannot deliver the empirical evidence of the joint effects of foreign competition on both job creation and job destruction. In the case of an exogenous growth, all labor markets would lose jobs with no differences in job creation rate. Overall, these effects yield negative aggregate welfare effects due to the fall in income. Therefore, a naive application of the welfare effects formula in Arkolakis, Costinot, and Rodriguez-Clare [2010] would also wrongly predict welfare gains instead of welfare losses in this case.

<sup>24</sup>Specifically, this change is done while preserving the support of the Pareto distribution of productivity. In the example used in the text, I reduce the shape (or tail) parameter in the foreign country and then randomly assign productivities to foreign producers according to the new distribution.

## 6 Conclusion

In this paper, I study both empirically and theoretically the labor market effects on increased trade openness in the U.S. I document the impact of foreign competition on labor market outcomes and job flows across a panel of U.S. states using a novel dataset on all the establishment-level petitions filed for Trade Adjustment Assistance in the U.S. over the last three decades. I find a large differential effect of import competition on unemployment across locations. This effect is driven by both increased job destruction and reduced job creation. These findings are robust to controlling for location fixed effects, time fixed effects, income, industrial composition, heteroskedasticity and serial correlation at the panel-level. The results therefore confirm and extend the recent findings in [Autor, Dorn, and Hanson \[2011\]](#).

This paper also extends a model of international trade to incorporate unemployment and segmented labor markets facing different degrees of foreign competition. This novel model is built to be consistent with the empirical findings on the uneven impact of trade on unemployment across locations. The model can rationalize the correlated effect of import competition on job destruction and job creation because the locations that are more vulnerable to foreign competition are precisely the less productive ones. The model is used to estimate the welfare effects associated with the uneven effects of trade across locations. Some locations are severely affected or wiped out while other locations gain from the reduction in trade barriers. However, aggregate welfare gains from trade reforms are not lower as a result of reduced relocation across labor markets. In contrast, aggregate welfare effects can be negative in the case of an exogenous productivity growth in the foreign country since all labor markets workers on net in the domestic economy.

Overall, this paper makes a contribution to the growing literature on the labor market adjustments induced by trade reforms. Much has been left out in this investigation of unemployment, foreign competition and local labor markets. Given the findings in this paper, future work on welfare effects of trade reforms should probably focus on a richer set of labor market frictions and the drivers of technological change in negatively affected locations, firms, and workers.

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## 7 Appendix

### 7.1 Descriptive Statistics

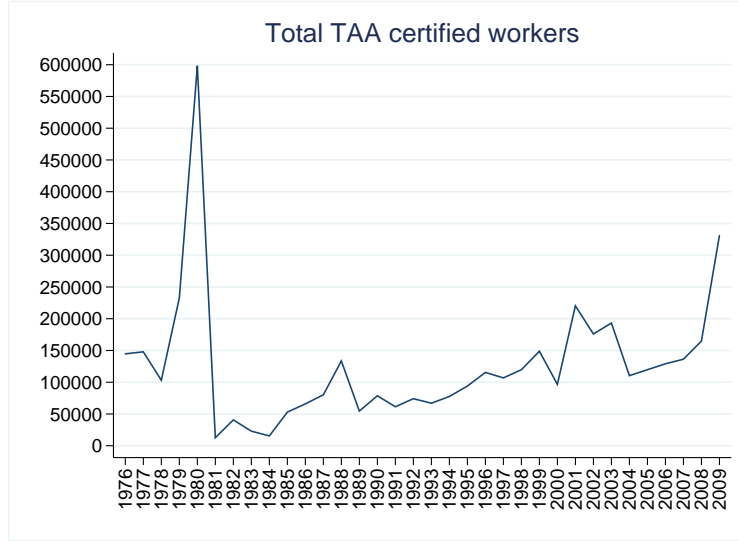
Table 5: TAA certified workers by state per thousand of w.a.p. (1983-2009)

| State   | Average | Minimum | Maximum | IQR  |
|---------|---------|---------|---------|------|
| AL      | 1.23    | 0.07    | 2.68    | 1.43 |
| AK      | 0.93    | 0.00    | 6.02    | 1.07 |
| AZ      | 0.33    | 0.03    | 1.47    | 0.27 |
| AR      | 1.08    | 0.06    | 2.37    | 1.21 |
| CA      | 0.25    | 0.03    | 0.74    | 0.23 |
| CO      | 0.57    | 0.01    | 2.98    | 0.47 |
| CT      | 0.44    | 0.04    | 1.01    | 0.47 |
| DE      | 0.25    | 0.00    | 3.38    | 0.30 |
| FL      | 0.13    | 0.04    | 0.29    | 0.13 |
| GA      | 0.70    | 0.01    | 1.56    | 0.60 |
| HI      | 0.06    | 0.00    | 0.70    | 0.08 |
| ID      | 0.67    | 0.00    | 1.86    | 0.63 |
| IL      | 0.45    | 0.02    | 1.87    | 0.38 |
| IN      | 0.84    | 0.02    | 3.23    | 0.86 |
| IA      | 0.38    | 0.00    | 2.10    | 0.49 |
| KS      | 0.57    | 0.00    | 3.01    | 0.60 |
| KY      | 0.91    | 0.02    | 2.56    | 0.84 |
| LA      | 0.59    | 0.00    | 4.50    | 0.61 |
| ME      | 1.32    | 0.43    | 2.66    | 1.09 |
| MD      | 0.23    | 0.01    | 0.60    | 0.24 |
| MA      | 0.58    | 0.05    | 1.63    | 0.34 |
| MI      | 1.00    | 0.03    | 6.89    | 0.98 |
| MN      | 0.47    | 0.01    | 2.05    | 0.33 |
| MS      | 1.19    | 0.02    | 3.00    | 1.20 |
| MO      | 0.74    | 0.06    | 1.33    | 0.46 |
| Overall | 0.67    | 0.00    | 7.35    | 0.71 |

| State   | Average | Minimum | Maximum | IQR  |
|---------|---------|---------|---------|------|
| MT      | 0.63    | 0.00    | 4.03    | 0.63 |
| NE      | 0.24    | 0.00    | 0.94    | 0.47 |
| NV      | 0.13    | 0.00    | 1.13    | 0.13 |
| NH      | 0.59    | 0.00    | 1.88    | 0.65 |
| NJ      | 0.54    | 0.13    | 1.07    | 0.41 |
| NM      | 0.61    | 0.00    | 3.00    | 0.69 |
| NY      | 0.39    | 0.07    | 0.74    | 0.20 |
| NC      | 1.37    | 0.07    | 3.77    | 2.18 |
| ND      | 0.57    | 0.00    | 5.66    | 0.48 |
| OH      | 0.80    | 0.18    | 3.71    | 0.76 |
| OK      | 0.74    | 0.01    | 2.14    | 0.47 |
| OR      | 0.90    | 0.00    | 4.40    | 0.82 |
| PA      | 0.95    | 0.14    | 2.44    | 0.44 |
| RI      | 0.89    | 0.00    | 1.95    | 0.87 |
| SC      | 1.10    | 0.02    | 2.78    | 1.65 |
| SD      | 0.46    | 0.00    | 2.86    | 0.33 |
| TN      | 1.31    | 0.22    | 2.68    | 1.03 |
| TX      | 0.61    | 0.07    | 2.55    | 0.41 |
| UT      | 0.64    | 0.07    | 3.43    | 0.53 |
| VT      | 0.53    | 0.00    | 1.85    | 0.82 |
| VA      | 0.63    | 0.10    | 1.97    | 0.36 |
| WA      | 0.63    | 0.02    | 5.42    | 0.35 |
| WV      | 0.62    | 0.05    | 2.06    | 0.61 |
| WI      | 0.78    | 0.10    | 2.68    | 0.77 |
| WY      | 0.87    | 0.00    | 7.35    | 1.12 |
| Overall | 0.67    | 0.00    | 7.35    | 0.71 |

## 7.2 U.S. TAA Series

Figure 12: Total number of TAA-certified workers in the US



I only use data post-1983 due to the unusual spike in the the data pre-1983. Significant changes in the program pre-1983 are documented in [Rosen \[2006\]](#). In particular, the auto-workers misused the program and the Reagan administration ultimately revamped it.

## 7.3 Population Dynamics

To see how population dynamics respond to trade shocks I run the following lagged dependent regression:

$$\text{US pop. share}_{t+1}^i = \alpha + \beta \times \text{import pressure}_t^i + \gamma \times \text{US pop. share}_t^i + \text{controls}_t^i + \text{error}_t^i$$

Using OLS, I obtain the following estimates:

$$\text{US pop. share}_{t+1}^i = \alpha + \underset{(0.149)}{-0.003 \times \text{import pressure}_t^i} + \underset{(0.007)}{+0.937 \times \text{US pop. share}_t^i}$$

$$R^2 = 0.9997$$

$$N = 1350$$

## 7.4 Government Transfers

$$\text{govt. transfers}_t^i = \alpha + 17.52 \times \text{import pressure}_t^i + \gamma \cdot \text{controls}_t^i + \text{error}_t^i$$

(4.715)

$$R^2 = 0.6658$$

$$N = 1350$$

In the government transfers regression above, the import pressure was rescaled by 1,000 and therefore expressed in numbers of TAA certified workers displaced per thousand w.a.p. The government transfers variable is the average yearly income received from the government (in 2005\$).

## 7.5 Unemployment Duration

Average unemployment durations are also slightly longer when import competition is higher as shown below:

$$\text{weeks unemployed}_t^i = \alpha + 0.507 \times \text{import pressure}_t^i + \gamma \cdot \text{controls}_t^i + \text{error}_t^i$$

(0.149)

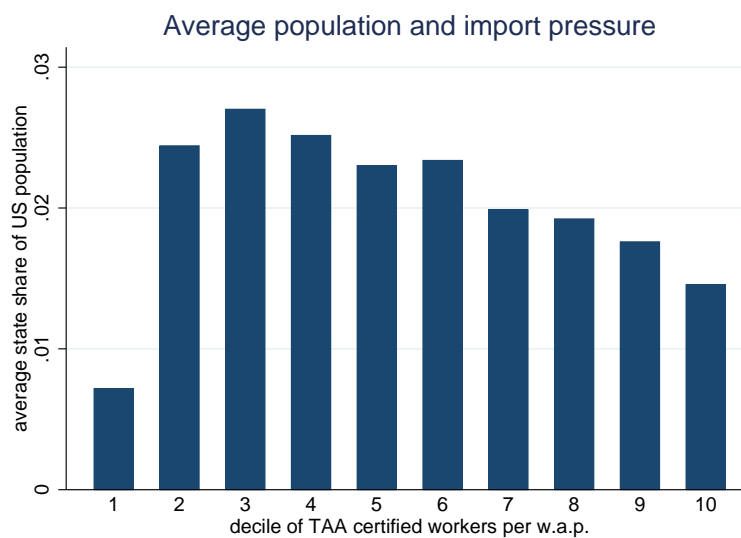
$$R^2 = 0.5351$$

$$N = 1350$$

In the unemployment spell regression above, the import pressure was rescaled by 1,000 and therefore expressed in numbers of Trade Adjustment Assistance (TAA) certified workers displaced per thousand w.a.p. The regression specification again included several controls (in particular time, location, income).

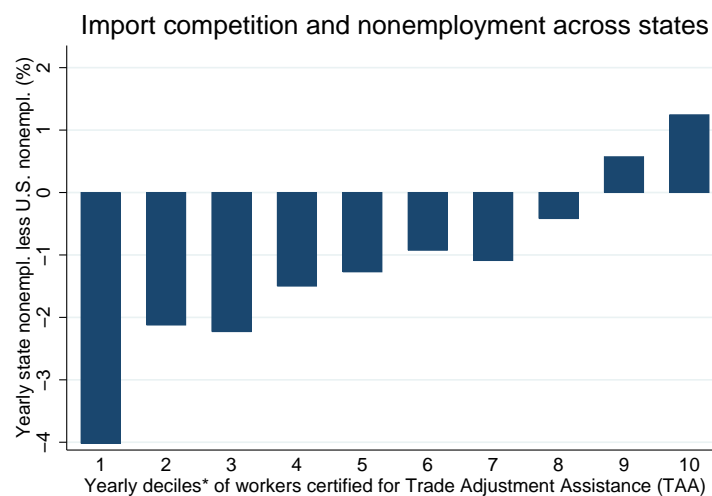
## 7.6 State Population and Import Competition

Figure 13: State population and import competition



## 7.7 Nonemployment and Import Competition

Figure 14: Nonemployment and import competition



\* Deciles are computed for each year across 50 states using workers certified for TAA per w.a.p.

## 7.8 State-level Variations in TAA Certifications

Figure 15: Within-year deciles across states of TAA import pressure



## 7.9 Comparing Different Measures of Import Pressure

Figure 16: Time series of import pressure (1988-1997;1999-2005)

