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A Rising Tide? The Local Incidence of the Second Wave of Globalization

Abstract

We estimate the short- and long-run local labor market impacts of the large increase in U.S. imports and exports that occurred over the 1970s. We exploit the sequential opening of overseas shipping container ports over the period, which generated discontinuous changes in U.S. trade ows. We find that the impacts of the export shock on employment, income, and home and rental prices were large, but short-lived, suggesting that U.S. local labor markets equilibrated quickly. The import effects were also large and mostly short-lived, but we find strong persistence in the impact on home and rental prices. We exploit differences in housing supply elasticities across markets to show that this is due to the fact that the housing stock is durable and so does not easily contract, a result with important welfare implications. Overall, we estimate that the net impact of the shock was to raise manufacturing sector employment by 250,000 workers over the decade of the 1970s.

JEL-Codes: F140, F160, F660, J210, R310.

Keywords: containerization, international trade, globalization, housing durability.

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1 Introduction

An important topic in current policy debates is the effect that international trade has on standards of living. While this topic has received a great deal of attention, the focus of the literature has largely been on short-run outcomes. We provide new evidence on the short- and long-run U.S. labor market effects of trade by exploiting discontinuous shifts in U.S. trade flows arising from innovations in shipping technologies in the 1970s. We find moderately-sized, positive effects on employment and income in the contemporaneous period, but much smaller or null effects in the longer run, suggesting that markets equilibrated fairly rapidly. We also explore the impact of the shock on the housing market, first confirming prior evidence that the housing supply function is kinked at the current level of supply. We show that this generates an asymmetry in the response of housing markets to the export versus import dimensions of the overall rise in trade, a fact that has thus far gone unexplored in the trade literature though it has quantitatively important welfare implications.

Our research design exploits the fact that the decade of the 1970s witnessed a doubling in the share of international trade in U.S. GDP, from four to eight percent, beginning what would become known as the second wave of globalization (see Figure 2). This rapid growth in trade was driven in large part by the widespread adoption of shipping containers to transport goods and the complementary investments in port and rail technologies that accompanied it.[1] The spread of these technologies was rapid – the share of U.S. trade that could be feasibly shipped via container grew from 16 percent to over 95 percent during the 1970s – generating growth in trade that was roughly balanced between imports and exports and that was driven by increased trade with a diverse set of countries.[2]

Since foreign adoption of container port technologies occurred quickly and was effectively complete by 1980, the sequence of port technology adoption around the world provides a well-defined, short-run historical shock that is well suited to an impulse-response research design. To do this, we exploit two features of this historical episode: first, the adoption of container port technologies in a foreign country generated a sudden and discontinuous rise in bilateral trade flows between the U.S. and that country (see Figures 3a and 3b); and second, the variation in trade flows due to the new port technologies differentially affected local labor markets in the U.S. due to differences in their pre-period industrial composition. In practice, we use this "shift-share" variation to construct measures of foreign-port-driven exposure to import and export shocks, a plausibly exogenous source of variation in trade flows that we can then use as instruments for observed local labor market exposure to trade.[3]

[1] See, e.g., Bernhofen et al. (2016) who estimate the contribution of containerization of trade flows to global trade growth over this period. The late 1960s and early 1970s also saw the phase in of the Kennedy Round of negotiations as part of the General Agreement on Trade and Tariffs (GATT). So policy changes undoubtedly generated some portion of this trade growth.

[2] Over the period 1966 to 1980, U.S. imports rose by a factor of 10 and exports by a factor of 8; for comparison, over the 1991 to 2007 period imports from China rose by a factor of 11.5 (see Autor et al. (2013)).

[3] As a robustness check, we generate the shift-share measure using a "double-lasso" approach (Belloni et al. (2012)), a method to select the best predictors of the dependent variable without over-fitting. This approach produces very similar results using a different source of underlying variation, supporting the robustness of our shift-share instruments (see Borusyak et al. (2018),

We estimate the contemporaneous (1970-1980), medium-run (1970-1990), and long-run (1970-2000) impact of export and import exposure on employment, income and home and rental prices across labor markets. As a first step, we show that the impact of the trade shock on median income diminishes over time, suggesting an equilibration of labor markets that is consistent with much of the labor literature that finds that factor movements mitigate the impact of local shocks.[4] Overall, our estimates indicate that the contemporaneous gains from export exposure outweighed the losses due to import exposure. We estimate that the export shock raised manufacturing sector employment by 550,000 workers over the decade of the 1970s, whereas the import shock reduced employment by around 300,000 workers for a net gain of around 250,000 jobs over a period in which the manufacturing sector grew by around one million jobs. The net average impact of exposure to exports and imports over this period was to raise relative median income by $3264.

Our next contribution is to explore the only outcomes that are impacted in an economically meaningful way beyond the short-run period, which are the persistent declines in home and rental prices that we observe in response to the import shock. This pattern is consistent with a model in which there are significant costs associated with reducing the housing stock in the face of a swift decline in demand for housing, a point that is the focus of Glaeser and Gyourko (2005). In that model the housing supply curve exhibits a kink at the current level of supply (see Figure 1). Since the housing stock cannot easily contract (except via slow depreciation), but in many locations can readily expand, the impact of a negative shock on home and rental prices cannot be quickly mitigated by a reduction in the housing supply. We discuss the implications of this model in an international trade context in Section 2 and provide a more formal description in Appendix A. In short, the model predicts that home and rental prices should fall more, and quantities should fall less, due to an import shock relative to an export shock. In addition, the import effects should persist. Our estimates provide strong evidence for this pattern of outcomes.[5]

Consistent with the literature, we also find heterogeneity in outcomes due to differences in the local housing supply elasticity. Here we proxy local housing supply elasticities with highly disaggregated differences in land unavailability from Lutz and Sand (2017).[6] Intuitively, we find that locations with a larger housing supply elasticity see smaller adjustments in home and rental prices due to the export shock (i.e., due to an outward

Goldsmith-Pinkham et al. (2018), and Adao et al. (2019b)).

[4]This result diverges somewhat from recent findings from Dix-Carneiro and Kovak (2017) who explore a similar time period and find that Brazilian regions that were hit relatively hard by a trade liberalization episode experienced income effects that steadily grew over time. It is difficult to know exactly what explains these divergent findings, but one possibility is that U.S. capital and labor markets may have been more integrated geographically over the period we examine relative to labor markets in Brazil. Undoubtedly, the difference in findings points to the importance of specific institutional and geographic barriers in mediating the effects of trade shocks.

[5]Interestingly, these findings contrast with Feyrer (2009) who finds that the positive effect on GDP due to the opening of the Suez Canal was equal in magnitude to the negative effect due to the closing of the Canal. Donaldson (2015) points out that while this result is consistent with standard static models of trade, the Feyrer (2009) result is inconsistent with a dynamic model in which physical or human capital investments respond positively to increased trade, but do not immediately decline when trade ceases – i.e., a model with asymmetric factor adjustment costs. Here we are focused on export versus import competition, rather than levels of trade openness as in Feyrer (2009), but we indeed find evidence that (housing) capital adjustment costs are asymmetric.

[6]Recent related work that exploits heterogeneity in housing supply elasticities includes Hornbeck and Moretti (2018), Monte et al. (2018), and Monte (2015).

shift in demand). We calculate that the average housing and rental supply elasticities due to the export shock are around 1.3 and 1.8, respectively. In contrast, we find that the size of the local housing supply elasticity has no impact on the home and rental price response to the import shock (i.e., due to an inward shift in demand), consistent with a kinked housing supply curve.

In a final section we calculate the magnitude of the *indirect* effects associated with the general equilibrium migration of workers across labor markets in response to the shock. Our approach here is similar to Hornbeck and Moretti (2018) but differs in that we allow for a kinked housing supply function and simultaneously consider both positive (export) and negative (import) shocks. We apply labor-market-specific housing supply elasticities calculated from our estimates of the direct effects and find that the cumulative magnitude of the indirect effects are economically meaningful. In a final section we combine the direct and indirect effects and explore heterogeneity in the total impact of the trade shock across individual labor markets. We show that the largest welfare gains accrued to residents of labor markets that simultaneously experienced a relatively large export shock, had a relatively low housing supply elasticity, and had a relatively high home-ownership rate – Charlotte, Houston, Los Angeles, and Atlanta are examples from the top ten. As a result of these features, housing markets in these areas saw relatively large increases in property prices that benefited a large share of residents. In contrast, the largest welfare losses accrued to residents of markets that simultaneously experienced significant import shocks and had high home-ownership rates – areas like Cleveland, Detroit, Toledo, and Pittsburgh.

The local labor market effects of international trade have been explored in many recent papers, for instance Topalova (2010), Acemoglu et al. (2016), Autor et al. (2013), and Hakobyan and McLaren (2016). These papers tend to focus exclusively on the effects of import competition, driven either by foreign shocks or changes in trade policy. Kovak (2013) is similar and focuses on a trade liberalization period, though does not separate import from export effects. Feenstra et al. (2019) and Feenstra and Sasahara (2018) are examples of work that incorporate both export and import exposure due to Chinese and global economic growth, with both papers focusing on employment outcomes in the short run. Also similar to our paper, Monte (2015) focuses on the impact of trade shocks on standards of living across local labor markets. He also finds rapid equilibration across markets, finding that there is little relationship between local import exposure and the real wage due to the fact that changes in local prices and commuting patterns offset changes in nominal income. Adao et al. (2019a) similarly estimate the aggregate (direct and indirect) effects of labor market exposure to a different set of shocks. Other recent work has explored the role of new port technologies during this era. For instance, Bernhofen et al. (2016) estimate the contribution of new port technologies to the rise in global trade over the containerization period, while Ducruet et al. (2020) and Brooks et al. (2018) consider port development as a shock to the local economy that is hosting the port. With respect to the housing market, Notowidigdo (2020) finds evidence for a concave housing supply function in the face of local labor demand shocks. Our context allows for a direct test of the shape of the housing supply function around the current level of supply due to the fact that we simultaneously observe both positive (export) and negative (import) demand shocks as well as local housing supply. Our paper also departs from much of the literature by simultaneously focusing on export and import exposure due to a global technological shock, by exploring the impact of international trade on housing markets, and by estimating the indirect effects along with the direct effects over the short and long run.

The paper is organized as follows. We outline our theoretical framework in Section 2. In Section 3 we describe our research design, including the dataset and identification strategy. In Section 4 we report our estimates of the direct effects of import and export exposure on local labor markets, including heterogeneity in these effects due to differential housing supply elasticities. Section 5 concludes.

2 Conceptual Framework

We begin by outlining a spatial equilibrium model that links trade shocks to labor and housing market outcomes and that hews closely to Glaeser and Gyourko (2005); a formal version of the model is described in Appendix A. The intuition of the model departs from standard spatial models only due to the existence of a kinked housing supply curve, which alters the relative impacts of export versus import shocks in both the labor and housing markets.

First, a trade shock in some local labor market leads to a net increase, or decrease, in the demand for labor, depending on the relative size of the export versus import effects.[7] Figure 1 depicts these demand shifts along with the subsequent reaction of housing markets. When the export effect exceeds the import effect, the impact on labor demand is positive (D_0 to D_E in the Figure) and, as a result, wages rise and workers migrate in from surrounding labor markets. At the same time, the local demand for housing rises, leading to new home construction (Q_0 to Q_E) that subsequently mitigates the upward pressure on home prices (which rise from p_0 to p_E). In contrast, a trade shock that is balanced toward import effects (D_0 to D_I) will reduce the demand for labor, leading to a net decline in the demand for housing. However, in this case, the housing supply falls only by the slow rate of depreciation of the housing stock in each period (Q_0 to Q_I^j in period j), which leads to a relatively large decline in home prices (from p_0 to p_I^1 after the first period). In other words, the trade shock manifests as a change in home prices rather than home quantities when the housing stock is effectively fixed.

The extent of worker migration into and out of a labor market differs in these two cases as well and, as a result, the employment impact is asymmetric. To see this, we first note that in the general equilibrium the real wage, $\frac{w}{p} \equiv \bar{U}$, must be equalized across labor markets (and here assumed to be fixed at $\bar{U}$). The difference in migration outcomes arises from the different response of the housing supply in response to a net export

[7]Note that not only are the relative magnitudes of the export and import shocks important, but their elasticities with respect to local labor demand also determine the net effect of the shock.

versus import shock: for a net *export* shock, the mitigation of home price rises due to new home construction strengthens the real wage impact of the shock in the short-run and, thus, increases in-migration, reducing nominal wages until $\frac{w}{p} \equiv \bar{U}$ again. On the other hand, for a net *import* shock there is only a small mitigating force on housing supply, so home prices see a relatively large fall, which makes workers less likely to migrate out, thereby sustaining the real wage $\bar{U}$. Thus, the kinked housing supply curve leads to an asymmetry in the migration – hence, the employment – response to export versus import shocks.

The intuition described above leads to the following propositions, which are formally derived in Appendix A:

Proposition 1 *In the short run, the expansion in housing units and employment in response to a positive labor demand shock will exceed the decline in housing units and employment in response to a negative labor demand shock.*

We also note the following corollary:

Corollary 1.1 *The impact on housing units and employment due to a negative labor demand shock persists beyond the initial period, while the impact due to a positive shock does not.*

Proposition 2 *When the housing stock is durable, median home prices will fall more in response to a negative labor demand shock than they rise in response to a positive labor demand shock.*[8]

Again we have the related corollary:

Corollary 2.1 *The impact on home prices due to a negative labor demand shock persists beyond the initial period, while the impact due to a positive shock does not.*

3 Research Design

We explore the impact of the rapid expansion in U.S. trade beginning in the late 1960s on employment, home prices and rental prices, and nominal income. To do this, we estimate three separate specifications capturing the local projection of the shock on outcomes across 722 U.S. Commuting Zones (labor markets), l, over the short, medium and long run.[9] These impulse-response specifications are given by the following:

$$y_{lt} - y_{l,1970} = \beta_t^x \triangle E_{l,66-80}^X + \beta_t^m \triangle E_{l,66-80}^M + \gamma_t MS_{l,1959} + \omega_t \big(y_{l,1970} - y_{l,1960}\big) + \alpha_s + \varepsilon_{lt} \quad (1)$$

[8] In contrast, in the model described in Notowidigdo (2020) the change in rental prices is symmetric in response to positive and negative shocks. This is because housing is homogenous within a labor market – i.e., locational amenities (distance from the CBD) play no role. As a result, rental prices simply rise or fall symmetrically in order to offset the local rise or fall in wages.

[9] Jordà (2005) describes the advantages of the local projections approach to estimating impulse-responses.

where y_{lt} is the log value of a local outcome and $\{\beta_t^x, \beta_t^m\}$ are the effects of export and import exposure, respectively, for $t \in \{1980, 1990, 2000\}$. The variables $\triangle E^X$ and $\triangle E^M$ represent the change in export and import exposure in a labor market over the containerization period, 1966 to 1980; α_s are state fixed effects to control for state-specific policy variation; and $\left(y_{l,1970} - y_{l,1960}\right)$ are pre-period decadal changes in the outcome variables. We also control for the output share of manufacturing in 1959, $MS_{l,1959}$, in order to focus on variation due to differences in the industry mix *within* the manufacturing sector across labor markets. We weight observations by the start-of-period (1959) labor market employment. We note that the outcomes vary across specifications – reflecting contemporaneous, medium-run, and long-run changes – but the treatment variables do not. As a result, the estimated effects can be interpreted as the contemporaneous-, medium-, and long-run impulse-responses to the common trade shock, where the impulse is sudden and large and effectively over by 1980.

3.1 Data and Variable Construction

Our measures of export and import exposure are the commonly used measures from Autor et al. (2013) and are given by:[10]

$$\triangle E^X_{l,66-80} = \sum_j \frac{L_{lj,1959}}{L_{l,1959}} \frac{\triangle X_{j,66-80}}{Y_{j,1959}} \tag{2}$$

$$\triangle E^M_{l,66-80} = \sum_j \frac{L_{lj,1959}}{L_{l,1959}} \frac{\triangle M_{j,66-80}}{\left(Y_{j,1959} - X_{j,1959} + M_{j,1959}\right)} \tag{3}$$

where L_{lj} is employment in labor market l and four-digit Standard Industrial Classification (SIC) industry j and Y_j is total shipments in industry j. The denominator in (3) is therefore industry absorption. In words, the national-level change in export share of industry output, or industry import penetration, over the period 1966 to 1980 is allocated to local labor markets according to the relative importance of each industry in the local market in 1959. These industry values are then summed up to the local labor market level (with employment weights that sum to 1).

We obtain values for employment in a four-digit SIC industry and county ($L_{lj,1959}$) from the County Business Patterns (CBP) for 1959,[11] 1960, 1970, 1980, 1990, and 2000.[12] National industrial output data for 1959 ($Y_{j,1959}$) come from the National Bureau of Economic Research, Center for Economic Studies (NBER-CES) Manufacturing Industry Database. Our use of 1959 shares, before the start of the sample period, follows the

[10] In practice, we use the related measures described in Acemoglu et al. (2016).

[11] We obtained the 1959 data from the Hathi Trust as pdfs, which we digitized.

[12] The 2000 and 2010 CBP data are converted to U.S. SIC industries using a concordance from Pierce and Schott (2012).

best practice for shift-share estimators outlined in Goldsmith-Pinkham et al. (2018). Values for U.S. imports and exports by origin and destination across four-digit SIC industries over the period 1966 to 1980 come from Feenstra et al. (2005) and are deflated using the Personal Consumption Expenditure (PCE) price index to 2012 values.[13] Figures 5a and 5b plot the distribution of the measures (2) and (3) across U.S. labor markets. One key fact highlighted by the Figures is the very different geographic distributions of export versus import exposure, which will be useful for identifying their relative impacts.

Our outcome variables of interest are at the commuting zone (labor market) level, which is aggregated from the underlying county-level data as in Autor et al. (2013).[14] These variables are decadal total employment, drawn from the CBP with missing values interpolated via the fixed point algorithm used by Autor et al. (2013); decadal median housing prices and rental prices, drawn from the Census of Housing and Population (CHP) in each decade from 1960 to 2000; and decadal median income from the CHP, again over the period 1960 to 2000. Values are deflated using the 2012 PCE.

In the construction of our instrumental variables, described in the next section, we exploit data from several additional sources. Our main variation comes from the sequence of international port and rail expansions over what we consider to be the "containerization period", 1966 to 1980.[15] Over this period countries around the world progressively upgraded their port and transportation infrastructure to varying degrees in order to efficiently handle shipping containers. The year in which each country became capable of handling containers is obtained from Bernhofen et al. (2016), who compiled these data from the *Containerization International Yearbook*. Figure 6 documents the sequence of major port openings along with total (imports plus exports) U.S. trade with each country in the year in which the container port opened. This containerization indicator – denoted $Port_{ct}$, where c is country of origin or destination – is set to 1 in the year in which either the country's port or rail infrastructure is able to handle shipping containers (and is 1 in all subsequent years). By including rail capability the indicator allows for variation due to rail traffic that may be linked to container-ready ports in other countries, such as Rotterdam in Europe (a major hub of container traffic); however, the results are almost entirely invariant to the use of a "port-only" (no rail) indicator. Finally, we drop Canada and Mexico from the sample since trade with these countries clearly relies on a large number of land border crossings, which mitigates the impact of ports. Trade with these countries is also more likely to be endogenous to economic conditions in U.S. local labor markets.

When constructing our instrumental variables, we sometimes include interactions of the containerization indicators with distance to the foreign country, bilateral tariffs, and other standard bilateral gravity measures, which we obtain from Fouquin et al. (2016). We also include interactions with an indicator for whether a product

[13]One nice feature of the data is that both the CBP and trade data are reported at the SIC 4-digit level, so the match is very clean, minimizing measurement error. When matching to 1959 data we do have to concord the CBP data to the 1972 SIC classification, which requires relatively minor adjustments.

[14]The county-to-labor market concordances are from David Dorn: http://www.ddorn.net/data.htm

[15]Globally the containerization period was 1966 to 1983, but U.S. trade flows were 97 percent containerizable by 1980.

is able to be containerized or not, again obtained from Bernhofen et al. (2016). Non-containerizable products include, for example, finished autos and certain steel products and constitute 20 percent of total U.S. trade, on average, over the period. Importantly, this indicator is drawn from a 1968 analysis by the German Engineer's Society and so pre-dates the subsequent rapid growth in container traffic. In Section 3.2.2 we further exploit the non-containerizability of some products as a placebo test of our research design.

Table 1 presents summary statistics for the main trade exposure variables along with the main dependent variables, each of which is multiplied by 100 throughout for ease of interpretation. We note that the distribution of both trade exposure variables across labor markets is such that a 5 percentage point difference in either import or export exposure is approximately equal to the difference in exposure between the labor market at the 90th percentile and the labor market at the 10th percentile. In an absolute sense, the change in trade exposure over the period 1966 to 1980 was large, with U.S. imports rising by a factor of 10 and exports by a factor of 8; by comparison, over the 1991 to 2007 ("China shock") period imports from China rose by a similar factor of 11.5 (see Autor et al. (2013)). On average, labor markets saw a change in export and import exposure over the 1966-1980 period of 2.02 and 2.24 percentage points, respectively. There is significant skewness to the distribution as evidenced by the much smaller median values. The 1970s also saw rapid growth in all of the outcome variables, particularly home prices and rental prices, with later years seeing more moderated growth (or declines in the case of manufacturing employment).

3.2 Identification

Our outcomes of interest are at the U.S. local labor market level. As a result, in specification (1) the exclusion restriction will be violated if shocks to local labor markets within a state and labor market are systematically correlated with both the extent of local exposure to imports and exports as well as with the error term (and not absorbed by the pre-trend controls or the manufacturing share in 1959). For instance, increasing efficiency gains due to automation in some industry may generate new U.S. exports in labor markets in which those industries are active, while also directly affecting labor market outcomes in those labor markets.

Motivated by a model of bilateral trade, we address these threats to identification by exploiting the plausibly exogenous opening of foreign container ports around the world over the period 1966 to 1980. Due to the large fixed costs associated with building container-ready port and transportation infrastructure, most countries were reluctant to make these investments until there were sufficient container-friendly shipping routes already in place. As a result, early U.S. investments in container infrastructure along the Eastern seaboard and, later, investments by Western European countries were critical to developing the shipping routes that would spur subsequent investments by other countries. This led to a progressive opening of container-ready ports around the world over the period, as documented in Figure 6. As Table 6 documents, the main U.S. trading partners were early adopters so that by 1972 80 percent of U.S. trade went via container-friendly ports. This, of course, limits the temporal variation available due to the timing of port openings. At the same time, we show in Section 3.2.3 that port openings had very different impacts *across* countries due to differences in the distance to the U.S. and the level of bilateral trade policy barriers in place. Furthermore, as noted, some products were not containerizable, which meant that products were differentially affected by new container ports, leading to shifts in the composition of foreign trade with the U.S. Overall, these sources of heterogeneity generated substantial variation in labor market exposure to container-port driven trade (e.g., see Figures 5a and 5b).

The impact of the opening of a container port on trade flows was large and immediate. We see this in Figures 3a and 3b where we plot log bilateral exports and imports between the U.S. and its trading partners as a function of the time since the foreign partner adopted container infrastructure, where $t = 0$ is the year of adoption. Clearly there is a marked increase in both exports and imports (larger for exports) in the year in which the foreign port began handling containers. This discontinuity is the key variation that we exploit in our empirical strategy.

3.2.1 Instrumental Variable Strategy

Our approach is to instrument for observed local exposure to imports and exports over this period with *predicted* exposure.[16] To do this, we first note that in (2) and (3) the potentially endogenous components are the values $\triangle X_{j,66-80} = \sum_c \sum_{t=67}^{80} \triangle X_{jc,t:t-1}$ and $\triangle M_{j,66-80} = \sum_c \sum_{t=67}^{80} \triangle M_{jc,t:t-1}$, respectively, where we have simply written the change in total exports over the period as the sum over the annual changes across individual export destinations (c), and similarly for imports. Our goal is to generate predicted bilateral exports and imports between the U.S. and its trading partners in each year, $\hat{X}_{jct}$ and $\hat{M}_{jct}$, by isolating variation that is exogenous to U.S. local labor market conditions. These can then be summed over to get the predicted values $\widehat{\triangle X}_{j,66-80}$ and $\widehat{\triangle M}_{j,66-80}$, which will be used to construct new versions of (2) and (3) that will serve as instruments for the original measures.

To generate the predicted trade flows, $\hat{X}_{jct}$ and $\hat{M}_{jct}$, we start with the symmetric Constant Elasticity of Substitution (CES) equilibrium condition for exports from the U.S. to country c relative to those from some third country i to c, similar to Romalis (2007) and Feenstra et al. (2019) and again consistent with the Autor et al. (2013) model motivating our labor market shock in Section 2. A related condition holds for *imports* into the U.S. from country c and is also presented below. This approach allows us to derive our predicted flows structurally while also highlighting the sources of potential endogeneity. In Section 4.2.2 we present an alternative, non-structural approach using the double-LASSO method (Belloni et al. (2012)). The CES export ratio is given by:

[16] One advantage of this approach is that the use of predicted exposure mitigates possible bias due to the use of the shift-share instruments (see Borusyak et al. (2018))

$$\frac{X_{jvt}^{US,c}}{X_{jvt}^{i,c}} = \left(\frac{c_{jt}^{US} t_{jt}^{US,c}}{c_{jt}^{i} t_{jt}^{i,c}} \right)^{1-\sigma} \tag{4}$$

where $X_{jvt}^{US,c}$ and $X_{jvt}^{i,c}$ are exports from the U.S. or country i to c of product variety v in industry j and year t; c_{jt}^{i} is the industry-specific marginal costs of production in country i; $t_{jt}^{i,c}$ are industry-specific, bilateral iceberg trade costs between i and c; and σ is the elasticity of substitution. Assuming that there are N_{jt}^{US} and N_{jt}^{i} symmetric varieties produced in each industry in each country and year, so that $X_{jt}^{US,c} = N_{jt}^{US} X_{jvt}^{US,c}$ and $X_{jt}^{i,c} = N_{jt}^{i} X_{jvt}^{i,c}$, we can rearrange (4) to get:

$$X_{jt}^{US,c} = \frac{N_{jt}^{US} \left(c_{jt}^{US} t_{jt}^{US,c} \right)^{1-\sigma}}{\sum_{k \neq US} N_{jt}^{k} \left(c_{jt}^{i} t_{jt}^{i,j} \right)^{1-\sigma}} \sum_{i \neq US} X_{jt}^{i,c}$$

Taking logs we get:

$$\ln X_{jt}^{US,c} = \alpha_{jt}^{US} + \ln \left(t_{jt}^{US,c} (P_t^c) \right)^{1-\sigma} + \ln \left(\sum_{i \neq US} X_{jt}^{i,c} \right) - \ln \left(\sum_{i \neq US} N_{jt}^{i} \left(c_{jt}^{i} t_{jt}^{i,c} \right)^{1-\sigma} \right) + \varepsilon_{jt}^{c}. \tag{5}$$

where $\alpha_{jt}^{US} = \ln \left(N_{jt}^{US} \left(c_{jt}^{US} \right)^{1-\sigma} \right)$ are U.S. industry-specific shocks. We now also write trade costs, $t_{jt}^{US,c}(P_t^c)$, as a function of whether a foreign port is containerized, whereby $P_t^c = \{0, 1\}$ is an indicator for the existence of a container port in country c.

The third term in (5), $\sum_{i \neq US} X_{jt}^{i,c}$, reflects third-country trade flows with c that we can directly control for. Finally, the last term, $-\ln \left(\sum_{i \neq US} N_{jt}^{i} \left(c_{jt}^{i} t_{jt}^{i,c} \right)^{1-\sigma} \right)$, reflects third-country productivity or variety shocks (i.e., shocks to the trading partners of U.S. trading partners) as well as bilateral trade costs between those countries and j. In this sense, the model clarifies the identification issue: to the extent that these third-country variables end up in the error term and are correlated with both exports from the U.S. to country c and the timing of a container port opening in c, they will introduce omitted variable bias to our estimate of the impact of the container port opening on U.S. exports. However, it is important to note that our final specification will require only that this potentially endogenous variation is uncorrelated with U.S. local labor market outcomes. In other words, the relevant exclusion restriction will be violated to the extent that shocks to U.S. local labor markets during the containerization era were correlated with trade between U.S. trading partners and third countries in a way that also affected the timing of U.S. trading partner port infrastructure investments. Violations of the exclusion restriction would therefore occur only via several chains of influence.

Nevertheless, we attempt to control for the final term in (5) by adding controls for variety, productivity, and trade cost effects in third countries (and implement the IV strategy discussed above as well). To do this, we first construct a single trade-weighted measure of aggregate TFP for country j's trading partners in year t, where we use pre-period (1962) trade weights from i to c.[17] We also control for the log trade-weighted average tariff faced by country c when exporting to its trading partners i, which we denote $\overline{\tau}_t^c$. Ideally, we would also like to control for port openings in third countries, however these are highly (or perfectly in some cases) co-linear with the port opening variable of interest (for country c). In lieu of this, in a robustness check we focus only on the early container port openings, whose timing should be less correlated with container port openings in third countries, an issue that we explore in greater detail in the context of pre-trends in Section 3.2.2.

Following (5), we generate predicted bilateral exports from the coefficients on the port dummy and its interaction with a range of bilateral trade costs, which we take as a flexible functional form for $t_{jt}^{US,c}(P_t^c)$. Specifically, we estimate:

$$\ln X_{jt}^{US,c} = \delta_j + \gamma_t + \beta_1 P_t^c + \beta_2 \ln \mathbf{T}_{jt}^{US,c} + \beta_3 \left(P_t^c \times \ln \mathbf{T}_{jt}^{US,c} \right) + \beta_4 \ln \left(\sum_{i \neq US} X_{jt}^{i,c} \right) + \ln \overline{TFP}_t^c + \ln \overline{\tau}_t^c + \varepsilon_{jt}^c. \quad (6)$$

where $\mathbf{T}_{jt}^{US,c}$ is now a vector of bilateral trade costs between the U.S. and c and $\overline{TFP}_t^c$ is trade-weighted average TFP in country c's trading partners in each year, where trade-weights are constructed using 1962 trade flows.[18] Similarly $\overline{\tau}_t^c$ is the trade-weighted average tariff faced by country c when exporting to its trading partners. From here we calculate $\hat{X}_{jct}$ which, as noted above, we then use to construct measure (2), which serves as our IV for export exposure.

Finally, we note that the *import* equilibrium is symmetric to the export equilibrium (5), and is formally given by:

$$\ln M_{jt}^{j,US} = \alpha_{jt}^c + \ln \left(t_{jt}^{c,US} \right)^{1-\sigma} + \ln \left(\sum_{i \neq j} M_{jt}^{i,US} \right) - \ln \left(\sum_{i \neq j} N_{jt}^i \left(c_{jt}^i t_{jt}^{i,US} \right)^{1-\sigma} \right) + \varepsilon_{jt}^j. \quad (7)$$

where $\alpha_{jt}^c = \ln \left(N_{jt}^c \left(c_{jt}^j \right)^{1-\sigma} \right)$ are country c-specific shocks; $t_{jt}^{c,US}$ are symmetric bilateral trade costs; $\sum_{i \neq j} M_{jt}^{i,US}$ are third-country imports to the U.S.; and $-\ln \left(\sum_{i \neq c} N_{jt}^i \left(c_{jt}^i t_{jt}^{i,US} \right)^{1-\sigma} \right)$ are third-country shocks as before. We generate predicted imports following a symmetric specification to (6) with imports as the dependent variable and then use these values to construct measure (3), which serves as our IV for import exposure.

3.2.2 Further Threats to Identification

A potential concern is that there remains variation in the error term in (6) that is both correlated with the timing of container port openings as well as with U.S. labor-market-level outcomes.[19] Our structural approach

[17] Data on TFP come from the Penn World Tables.

[18] As discussed in the next section, the bilateral trade costs that we include are the distance to c, tariff barriers, a common language indicator, and a former colony indicator.

[19] Specification (1) also includes pre-trends in outcomes and state fixed effects, which may absorb a portion of this variation.

to generating predicted trade flows should go a long way toward eliminating this variation, as will the fact that in most cases U.S. labor market output is small relative to the volume of container traffic through any foreign port. Nevertheless, a good place to start in looking for additional problematic variation is in the relationship between U.S. bilateral trade and the timing of container port openings.

With this in mind, we ask whether pre-period bilateral trade flows between the U.S. and its partners can, on average, predict the timing of foreign container-port openings. Ideally, we would like to know whether port openings are as good as randomly assigned with respect to *counterfactual* changes in bilateral trade flows, but since we do not observe counterfactual outcomes we instead focus on pre-trends in outcomes, as is standard. We also split the sample in two ways. First, by early and late adopters of container-port technologies. This addresses the possibility that late adopters responded endogenously to the additional global trade generated by early adopters. Second, we split the sample by the share of U.S. trade in total trade in the destination or origin country, since countries with high U.S. trade shares are more likely to be responsive to U.S. labor market specific shocks, which is the primary threat to the validity of the exclusion restriction. As we see in Table 1 columns (1) and (2), conditional on controls there is no statistically significant relationship between the timing of port openings and the volume of bilateral trade with the U.S. in the 5 years preceding the opening, suggesting (though not proving) that container port openings are indeed as good as randomly assigned with respect to counterfactual changes in bilateral trade flows. In columns (3)-(10) we see that this result is robust to each of the samples. Nevertheless, in a robustness check in Section 4.2.1 we also estimate versions that exclude variation due to late adopters.

Finally, we note that we can exploit the fact that some products cannot be placed in containers in order to partially test the validity of our research design. Figures 4a and 4b are similar to Figures 3a and 3b except that they focus narrowly on trade in products that are not containerizable, presenting a placebo scenario in which trade should be unaffected. The Figures show that as expected the opening of foreign container ports did not raise the observable flow of non-containerizable trade.[20]

3.2.3 First Stage

We begin by presenting first-stage estimates of the impact of container port openings on our measures of U.S. local labor market exposure to imports and exports. As discussed in detail in Section 3.2.1, we first generate *predicted* bilateral imports and exports using exogenous variation from port openings. These predicted trade flows are then combined with pre-period employment across U.S. local labor markets to construct predicted labor market exposure measures based on (2) and (3). These measures are then used as instruments for *actual* labor market exposure to imports and exports.

[20]We note that there is some evidence of a partial crowding out of non-containerizable exports in the short-term as seen by the small drop in the treatment period in Figure 4a.

First, Table 2 presents estimates from specification (6) and its counterpart for imports – i.e., the regressions that generate predicted trade flows. The contemporaneous impact of container port openings on trade flows was economically large and statistically significant, indicating that port openings increased exports by between 200 and 300 percent over the period 1966 to 1980 (columns (2) and (3)) and increased imports by around 200 percent (columns (7) and (8)). This is consistent with the findings from Bernhofen et al. (2016) who find that container ports increased world trade by 350 percent over a 20 year period. The interactions with cross-country features indicate that the effect was increasing in the distance to the foreign port and decreasing in the level of foreign tariffs, while shared language had little differential impact. Being a former U.S. colony was associated with a relatively smaller impact. The strictest specification explains around 40 percent of the variation in log exports and imports.

We then generate predicted exposure to exports and imports by using the predicted flows to construct measures (2) and (3). Table 4 presents the first stage results, which indicate that the first stage is strong with an F-stat of 38.

4 Effect of the Container Shock

In this section we report our estimates of the short-, medium-, and long-run impact of container-driven import and export exposure over the period 1966-1980 on U.S. local labor markets and we evaluate the findings in the context of the theory and propositions presented in Section 2. We focus on employment, median income, median rental prices and median home prices.[21] In Section 4.3 we explore the consequences of a durable housing stock for outcomes, both in the short and long run, in part by exploiting heterogeneity in housing supply elasticities across markets. In Section 4.2 we explore robustness specifications that include a focus on early port technology adopters as well as an alternative IV strategy exploiting LASSO-based predicted trade exposures. Throughout, we multiply the trade exposure measures and outcomes by 100 for ease of interpretation.

When assessing the economic magnitudes of the shock and the implied elasticities we exploit the fact that for some outcome $y = \ln Y$, specification (1) implies that:[22]

$$\triangle Y_t = \sum_l \left[Y_{lt} \left(\mathrm{e}^{(\hat{\beta}_t^x \triangle E_{l,66-80}^X + \hat{\beta}_t^m \triangle E_{l,66-80}^M)} - 1 \right) \right] \tag{8}$$

where $\hat{\beta}_t^x \triangle E_{l,66-80}^X + \hat{\beta}_t^m \triangle E_{l,66-80}^M$ is the sum of the estimated export and import effects on the outcome over the period 1970 to t, given observed changes in export and import exposure in each labor market.

[21] We note that the estimates in this sub-section represent relative impacts across labor markets, rather than national-level effects. We calculate the indirect and national-level effects in Sections 4.4 and 4.5.

[22] Acemoglu et al. (2016) interpret this as the difference between the actual and counterfactual outcome in the case when there was no trade shock.

An additional consideration when interpreting the coefficients is the extent to which the medium- and long-run estimates reflect direct impacts on the outcomes or, rather, impacts arising from persistence in the treatment over time. In Appendix Section **??** we show that the treatment persistence channel is likely to be small so that the estimates are effectively direct effects.

4.1 Direct Effects of the Trade Shock

4.1.1 Housing Supply

Table 5 presents the OLS and 2SLS results for the change in local log housing units, following specification (1). The OLS estimates for the short-, medium-, and long-run are presented in Columns (1)-(3). Columns (4)-(6) report the 2SLS estimates for each period. All specifications include state fixed effects with standard errors clustered at the labor market level.[23]

Proposition 3 predicts that the quantities of housing and labor will respond asymmetrically to the trade shock. In estimating the separate response of housing units to the export and import shocks we can directly test whether the housing supply function indeed exhibits a kink at current supply, as depicted in Figure 1. Table 5 presents clear evidence of this asymmetry: the export shock generates a large contemporaneous rise in the supply of homes with continued, but smaller and statistically insignificant, increases in future periods; in contrast, the import shock has little impact on the supply of homes in any period. Below we combine these estimates with estimates of the home and rental price response in order to calculate the implied average housing supply elasticities due to the export and import shocks.

4.1.2 Employment

Table 6 presents the OLS and 2SLS results for the change in local log employment as in specification (1). The pattern of results indicates a clear contemporaneous impact: export exposure raises employment growth and import exposure reduces it. Consistent with Proposition 3, the short-run import effect is smaller than the export effect. In the medium-run (1970-1990) both the OLS and 2SLS estimates in Columns (2) and (5) indicate no statistically significant effect due to export exposure, but there is some evidence of a persistent negative impact on employment due to import exposure, consistent with Corollary 1.1, though with only marginal growth in the second decade. Columns (3) and (6) indicate no statistically significant impact on employment in the long run.

The contemporaneous 2SLS estimates in Column (1) indicate that, on average, a one percentage point increase in export exposure led to a 4.75 percentage point relative increase in employment. At the same time, a one percentage point increase in import exposure reduced relative employment by 2.13 percentage points. Table

[23] A regression of export exposure, or import exposure, on state fixed effects produces an R^2 of 0.06 and 0.25, respectively. So the bulk of the variation being exploited is within state and across labor markets.

7 highlights that this effect was concentrated in the manufacturing sector, with small employment spillovers to the non-manufacturing sector.[24] Given these estimates and the observed rise in export and import exposure over the period in each labor market, (8) implies that the export shock increased employment by around 550,000 workers while the import shock reduced employment by around 300,000 workers. Thus, the total effect of the trade shock was to increase employment over the 1970s by around 250,000 workers during a period in which the sector grew by about one million workers.

4.1.3 Income

Table 8 presents the OLS and 2SLS results where the dependent variable is the change in log median income. The results indicate a positive impact on income due to export exposure and a negative impact due to import exposure in the contemporaneous period. The contemporaneous 2SLS estimates indicate that a one percentage point increase in labor market export exposure led to a 4.16 percentage point relative increase in income, while a one percentage point increase in import exposure led to a 1.73 percentage point relative decline in income. Converting this to a dollar value using the initial-period (1970) median U.S. income and equation (8), we find that the net impact of the trade shock was to raise annual, median income over the period by $2,692 (in 2012 $). This accounts for around 9 percent of the overall rise in median income over the period.

The fact that the relative income effects are concentrated in the initial period, while diminishing in later periods (Table 8), suggests that markets equilibrated over time in response to the shock. This is also supported by the fact that the shock impacts relative employment growth very little beyond the short run. As noted in the Introduction, this contrasts with the results from Dix-Carneiro and Kovak (2017), who found that Brazilian regions that were hit relatively hard by import competition experienced employment losses that grew over time. It is difficult to know exactly what explains these divergent findings but, consistent with a simple general equilibrium model, they are suggestive of more severe labor and financial market frictions in Brazil relative to the U.S.

4.1.4 Home Prices and Rents

The impact on home prices is reported in Table 9 and the impact on rental prices is reported in Table 10. We find that the estimates for export exposure are similar for home prices and rents, with both rising in the contemporaneous period only. In contrast, the impact due to import exposure is negative, grows in magnitude over time in each specification, and is highly significant over the first two decades. The contemporaneous 2SLS estimates indicate that a one percentage point increase in export exposure produced a 4.24 percentage

[24] The manufacturing sector also shows signs of persistence in the employment effect due to the export shock in the medium run. This suggests that the lack of observed persistence in the labor market-wide estimates of the export shock in Table 6 is likely due to the mitigating effects of labor mobility across sectors within a labor market. Thus, the positive persistence in employment in the manufacturing sector in the medium run may have attracted workers from the non-manufacturing sector, reducing the labor market-wide employment gain due to the export shock. Finally, we note that there is no persistence in the long run in either sector.

point relative increase in home prices and a 3.78 percentage point relative increase in rental prices. For import exposure, a one percentage point rise led to a 5.20 percentage point relative decline in home prices and a 4.22 percentage point relative decline in rental prices. The medium-run estimates of import exposure on home values and rents are consistent with persistence in outcomes due to asymmetry in the housing supply function, and are equal to 5.91 and 6.21, respectively.[25] Adopting these medium-run values for the import effect, the dollar value net impact of the trade shock was to *reduce* annual, median home values by $2,935 and median rents by $404 over a period in which home values *rose* by around $85,000 and rents by around $5700 (all in 2012 $). About a third of the contribution to the rental price decline was due to persistence into the medium-run arising from the kinked housing supply curve.

Again, we note that the decline in home and rental prices represents a decrease in standard of living for incumbent home owners, and an increase for non-incumbent (future) home owners and renters. While the import effects are larger than the export effects, only the effect on rental prices is statistically different. We interpret this result as some evidence in favor of Proposition 4, which states that the fall in prices due to a negative shock will be larger in absolute magnitude than the rise due to a positive shock. Nevertheless, the persistence in the effect due to import exposure clearly stands out and is in line with Corollary 4.1, though the magnitude of the impact beyond the initial period is small, suggesting some cross-labor-market equilibration over time.

4.1.5 Consequences for Purchasing Power

The consequences for total purchasing power will differ between homeowners and renters. For renters, the change in purchasing power due to the trade shock can be calculated as the difference between the change in log income and the weighted change in log rental prices and log prices of local non-tradable, non-housing goods; i.e., $\Delta \ln w - \beta_H \Delta \ln p_H - \beta_{NT} \Delta \ln p_{NT}$ where the β's are weights and p_H and p_{NT} are the prices of housing and local non-tradable, non-housing goods, respectively. To calculate this, we adopt the weights used in construction of the Consumer Price Index (CPI), which are the average shares of local expenditure on housing (0.33) and non-housing goods (0.66). However, we are missing estimates of the trade shock on the price of local non-housing goods, for which data are scarce. In order to account for variation in these prices we therefore adopt the approach described in Hornbeck and Moretti (2018) and Moretti (2013). In short, Moretti (2013) estimates the relationship between changes in the price of local non-housing goods and changes in rental prices across a sample of U.S cities for which data are available, and then uses data on rental prices across all cities to impute the missing non-housing prices. On average, he finds that a one percent increase in rental prices is associated

[25] In Section 4.3 below we also find persistence in outcomes due to the *export* shock for CZs with low housing supply elasticities. This is consistent with the model and evidence presented thus far as it indicates that the housing supply elasticity is an important determinant of the extent of persistence in outcomes. In other words, much like the durability of the housing stock constrains housing supply on the downside, unusually high building costs will constrain supply on the upside (e.g., due to an export shock) over the short run, but less so over the longer run.

with a 0.35 percent increase in local non-housing goods. We use this elasticity along with our estimates of the response of rental prices to the trade shock to proxy for the change in local non-housing goods. The end result is that changes in purchasing power due to the trade shock are given by the difference between the change in log income and 0.56 times the change in log rental prices (see Hornbeck and Moretti (2018)).[26] Over the short run, our estimates in Tables 8 and 10 imply an overall rise in purchasing power for renters due to the net (exports - imports), direct impact of the trade shock equal to 2.7 percent, which increases to 3.5 percent when we use the medium-run estimates for the direct effect of the import shock on rental prices, accounting for its persistence due to the convexity of the housing supply curve. Here we see that the convexity of the housing supply curve leads to a non-trivial half percentage point purchasing power gain for renters.

For homeowners the calculation is more subtle since changes in home values are only relevant to the extent that the rise or fall in value passes through to changes in purchasing power. At one extreme, a homeowner could be fully insulated from a shock if they hold on to the home indefinitely and extract no equity, in which case any changes in value will have no impact on purchasing power. At the other extreme, homeowner purchasing power may be maximally impacted by the change in value, increasing or decreasing in perpetuity by an amount equal to the annual change in rent times the share of housing in expenditure – for instance, if the homeowner rents out the home immediately following the shock and moves to another city whose home prices did not change. In either case, the annual change in rent is the relevant measure of housing value when considering impacts on purchasing power. In the former case (fully insulated homeowners), we can ignore changing home and rental prices and account only for the impact of the shock on the price of local non-housing goods, which implies a purchasing power weight on log rental prices of 0.23 and an overall rise in purchasing power for homeowners due to the net impact of the trade shock equal to 2.5 percent,[27] which increases to 2.9 percent accounting for the medium-run persistence. In the latter case (fully liquidated homeowners) the weight on log rental prices falls to 0.10 and the overall rise in purchasing power is equal to 2.4 percent,[28] which increases to 2.6 percent over the medium run.

We revisit the role of relative home ownership rates across labor markets in Section 4.5 below. There we discuss the implications of the fact that home ownership rates are highly correlated with both local housing supply elasticities and relative exposure to the trade shock, a force for concentration of the effects of the trade shock.

[26] With Cobb-Douglas utility over a traded good, a non-traded good, and housing, where the price of the traded good is fixed, indirect utility (purchasing power) is given by $\Delta \ln V = \Delta \ln w - \beta_H \Delta \ln p_H - \beta_{NT} \Delta \ln p_{NT}$, where the weights are the expenditure shares. With an expenditure share of 0.33 for housing and a non-traded good price elasticity with respect to rental prices of 0.35, this can be re-written as $\Delta \ln V = \Delta \ln w - 0.35 \times 0.66 \times \Delta \ln p_H = \Delta \ln w - 0.56 \times \Delta \ln p_H$.

[27] The value 0.23 is the rental price elasticity with respect to non-tradable goods (0.35) times the non-housing consumption share (0.66).

[28] The value 0.10 is the housing consumption share (0.33) gain in purchasing power from rising rents minus the purchasing power loss due to the rise in non-tradable goods prices (as proxied by the weight on rental price changes of 0.23).

4.1.6 Implied Elasticities

We can use the estimates in Tables 5, 9, and 10 to calculate the average implied, short-run housing supply elasticities for output levels beyond current supply – i.e., to the right of the kink in Figure 1. To do this, we note that equation (8) implies that the percent change in an outcome over the period 1970 to t in labor market l – i.e., $\frac{\triangle Y_{lt}}{Y_{lt}}$ – due to the export shock is given by $\mathrm{e}^{(\hat{\beta}_t^x \triangle E^X_{l,66-80})} - 1$. Evaluating this at the mean value of export exposure, $\overline{\triangle E^X}_{66-80}$, we can calculate the average housing supply elasticity induced by the positive export shock (i.e., along the housing supply curve *above* current supply):

$$\varepsilon_t^{HS} \equiv \frac{\%\triangle Q_t^H}{\%\triangle P_t^H} = \frac{\mathrm{e}^{(\hat{\beta}_t^{Qx}\overline{\triangle E^X}_{66-80})} - 1}{\mathrm{e}^{(\hat{\beta}_t^{Px}\overline{\triangle E^X}_{66-80})} - 1} \tag{9}$$

where $\hat{\beta}_t^{Qx}, \hat{\beta}_t^{Px}$ are the estimates of the impact of the shock on housing quantities, Q_t^H, and home prices, P_t^H, respectively. A similar elasticity can be obtained for rental prices. These calculations give export-induced average housing supply elasticities with respect to home prices and rental prices over the period 1970-1980 of 1.31 and 1.80, respectively,[29] such that each 1 percent rise in the number of households in a labor market due to the export shock increased the average price of homes by 0.82 percent and the average price of rental units by 0.57 percent (applying the inverse elasticities).[30] We further note that the implied supply elasticities due to the *import* shock (i.e., along the housing supply curve *below* current supply) are much smaller and mostly near zero, though the coefficients ($\hat{\beta}_t^{Qm}, \hat{\beta}_t^{Pm}$) are not precisely estimated.

4.2 Robustness

4.2.1 Focusing on Early Adopters

Here we present estimates from specification (1) except that the IVs are now constructed using only variation from foreign-country port openings during the 1966-1973 (early) period. As noted in section 3.2.2, the investments in port technologies made by late adopters were more likely to be motivated by prior port openings around the world and the increasing global trade flows that followed. These port openings may therefore be endogenous to local U.S. outcomes to the extent that these outcomes were also driven by prior port openings. Appendix Tables B.1 and B.2 reproduce our main 2SLS specifications but using this early period variation only, where we see a local average treatment effect that is similar in magnitude to the estimates in Tables 6 through 10, indicating that late adopters did not differentially affect outcomes in an economically important way.

[29] Saiz (2010) reports a similar average housing supply elasticity of 1.54 at the MSA level. Gyourko (2009) reports estimates from the literature ranging from 1 to 3.

[30] This is consistent with other findings in the literature showing that rental prices are less responsive than home prices to shocks.

4.2.2 LASSO-based IVs

We also applied a double-lasso approach (Belloni et al. (2012)) to generate predicted exports and imports in the construction of the instrumental variables, rather than using the structural approach described in Section 3.2.1. The idea is to begin with a large set of regressors and find the "best" predictors of bilateral trade flows without over-selecting potentially spurious covariates. We include the port opening indicator and a set of typical "gravity" variables (bilateral distance, bilateral tariffs, common language, former colony), along with interactions between each one of them. We then use the best predictors to generate predicted imports and exports and use these to construct instruments for (2) and (3). The first stage F-Stat in this case is 75, quite a bit stronger than when using the structural IVs. Appendix Tables C.3 and C.4 reproduce the main 2SLS specifications using these new IVs, where we see that this local average treatment effect is somewhat larger than the baseline estimates. The similarity of the estimates is important confirmation of the size of the effects, given the potential bias that is highlighted in the recent literature on shift-share research designs (e.g., Borusyak et al. (2018), Goldsmith-Pinkham et al. (2018), and Adao et al. (2019b)).

4.3 Heterogeneity in Outcomes

In this section we explore the role of heterogeneity in the local housing supply elasticity and estimate labor-market-specific housing supply elasticities. We use these elasticities in the next section where we calculate the indirect effects of the trade shock. Proposition 5 highlights the standard result that in the face of an *export* shock the housing stock adjustments will be relatively quick, and home and rental price effects relatively mitigated, in areas with relatively large housing supply elasticities. However, we also expect the home and rental price response due to an *import* shock to be invariant to differences in local housing supply elasticities since contraction occurs only via the slow process of depreciation, whose rate should be unrelated to the local housing supply elasticity. In Figure 1 this implies that the supply curve to the left of the equilibrium point is fixed across labor markets in the short run, whereas there may be significant heterogeneity in the slope of the supply curve to the right of the equilibrium.

Proposition 5 also states that the housing supply elasticity is a decreasing function of local building costs. With this in mind, we split specification (1) into two subsamples, high building cost CZs (low elasticity) and low building cost CZs (high elasticity). Specifically, we use a measure of the share of local land that is unavailable for development due to the steepness of the slope or other natural impediments such as oceans, rivers, lakes, etc., which serves as a proxy for building costs. This measure is drawn from Lutz and Sand (2017) and expands on the popular measure developed by Saiz (2010), in part by providing more detailed geographic variation. Importantly, Lutz and Sand (2017) show that the measure is uncorrelated with housing demand factors and so represents a reliable proxy for supply constraints in the housing market. We exploit county-level values that we aggregate up to the local labor market level. Generally speaking, the literature has found that total land unavailability is an important determinant of growth in home prices and rental prices – e.g., see Glaeser et al. (2008) or Mian and Sufi (2011). In our case, regressing home price growth (each period stacked, 1970-2000) on total land unavailability (which is time invariant and assumed to be pre-determined) and applying the coefficient, we calculate that labor markets at the 90th percentile of total land unavailability experienced growth in home prices over the period that was 14 percent greater, on average, than the 10th percentile, and 16 percent greater in the case of rental price growth.

Table 11 presents estimates for the housing supply, price, and rent versions of specification (1) with each set of estimates split into the two subsamples. Formally, we define high building cost CZs – those with high land unavailability and therefore low housing supply elasticities – as those above the median land unavailability, and low building cost CZs – those with low land unavailability and high elasticities – as those below the median. The estimates indicate that export exposure raises the supply of homes along with home prices and rents in the contemporaneous period, in both high- and low-elasticity areas. The effect size on housing supply is statistically smaller for low-elasticity CZs, consistent with less mitigating expansion in housing supply in response to the shock and consistent with Proposition 5. At the same time, the effect persists into the medium-run in the low-elasticity case suggesting that the equilibration of the housing market is slower. Home values and rental prices also respond consistent with the model, with smaller export effects in relatively high-elasticity areas. Taking the mean export exposure over the contemporaneous period, a CZ at the 90th percentile of land availability experienced a 23 percent smaller rise in home prices and a 19 percent smaller rise in rents relative to a CZ at the 10th percentile of land availability.

Import exposure, on the other hand, produced persistent outcomes of similar effect size in both cases – i.e., the effect was mostly invariant to the magnitude of the housing supply elasticity – consistent with Proposition 5. Along with the direct evidence from Table 5, the constancy of import effects across labor markets facing very different housing supply elasticities offers strong support for the hypothesis that asymmetry in the housing supply response to positive versus negative shocks drives the asymmetry in key labor market outcomes. We do note that the import exposure effects may not be totally invariant to the housing supply elasticity: whereas our model predicts no difference in the effect of an import shock across CZs with differing housing supply elasticities, we instead see that high-elasticity CZs may have experienced a somewhat more negative price response to the import shock, though the estimates are not statistically different.

Similar to the calculation of the average export-induced housing supply elasticities above, the estimates from Table 11 can be used to construct labor-market-specific housing supply elasticities. To do this, we follow the same approach as above and combine the estimates from Table 11 with the observed changes in export and import exposure. This local housing supply elasticity (now indexed by l) is given by:

$$\varepsilon_{lt}^{HS} = \frac{\mathrm{e}^{\left(\hat{\beta}_{1t}^{Q}\overline{\triangle E^{X}}_{66-80}\Lambda_l + \hat{\beta}_{3t}^{Q}\overline{\triangle E^{X}}_{66-80}\right)} - 1}{\mathrm{e}^{\left(\hat{\beta}_{1t}^{P}\overline{\triangle E^{X}}_{66-80}\Lambda_l + \hat{\beta}_{3t}^{P}\overline{\triangle E^{X}}_{66-80}\right)} - 1} \tag{10}$$

where again $\hat{\beta}_t^Q, \hat{\beta}_t^P$ are the estimates of the export impacts on housing quantities and prices, respectively, and we perform a similar calculation for rental prices. The resulting elasticities display significant heterogeneity within reasonable bounds: the 90th percentile elasticity with respect to home prices is 3.81 while the 10th percentile is 1.13. For rental prices the 90-10 values are 3.02 and 0.80. We use the latter labor-market-specific elasticities in our calculation of the indirect effects of the trade shock in the next section.

4.4 Indirect Effects of the Trade Shock

In this section we use our estimates of the direct effect of the trade shock in some labor market l to infer the indirect effects of that local shock on other labor markets o, using an approach that is close to Hornbeck and Moretti (2018). We note that we necessarily make important assumptions in producing these estimates (about the labor supply elasticity and the pattern of migration across labor markets) and so the values should be interpreted with that in mind. In short, we use our estimated housing supply elasticities, along with an assumed labor demand elasticity, to calculate the impact of the general equilibrium movement of workers across labor markets due to the trade shock in l on income and home and rental prices in each labor market o.[31] We calculate both short- and medium-run effects, where the latter include the medium-run impact on home and rental prices and account for the persistence in these effects. The indirect effects in each o associated with a shock in some l can then be summed over to obtain the indirect effects associated with each l, and these can be summed over to obtain the national-level indirect effects.

As a starting point, we use our estimates of the direct employment impact of the trade shock from Table 6 to generate the predicted net (export effect - import effect) change in employment in each labor market l due to the shock. Note that for some labor markets this will be a positive value and for others a negative value (when the import competition impact dominates). Next, we assume that the change in employment in l derives from migration into or out of l from other labor markets o, and we allocate a portion of the total employment change in l to each o, such that o's workforce rises or falls due to the shock in l. Since we cannot observe the actual pattern of migration in response to the shock, we instead use 1980 Census data on individuals' location of previous residence to allocate employment changes in labor market l due to the trade shock according to the share of workers who migrated to l from some labor market o during that period (or out of l into o in the case where import competition dominates and l sees net out-migration).[32]

[31] We assume there is no international migration and that employment changes in a labor market are due to increases in the number of workers only, rather than an increase in hours worked by existing workers.

[32] Specifically, we impute the labor market of previous residence by using the Census data to estimate a gravity model of migration across Metropolitan Statistical Area (MSA) pairs over the period 1975-1980 (the earliest date range for which Census reports

Finally, we use our estimates of the labor-market-specific housing supply elasticities calculated in Section 4.3, along with a uniform labor demand elasticity drawn from Hornbeck and Moretti (2018) of -0.15,[33] to calculate how the indirect employment change in each labor market o impacts o's home prices, rental prices, and income. To do this we use Census data on the number of workers per household in 1970 in each labor market in order to map the change in employment in a labor market into a change in the number of housing units in that labor market. We then apply the calculated housing supply elasticities to get the implied percentage change in rental prices. Given the initial levels of rental prices in 1970, we use these estimates to calculate the total dollar change in rental prices over the short run (1970-1980) and, separately, the medium run (1970-1990), accounting for the observed persistence in the latter case. We then follow the same process to calculate the dollar change in income over the period using the assumed labor demand elasticity. These indirect outcomes can then be summed up across o to get the total indirect impact on workers due to each l's direct exposure to the trade shock. Summing over l then gives the national-level indirect effect.

Dividing this national-level effect by the number of U.S. workers, we find that the indirect effects of the trade shock raised annual income per worker (in 2012 $) in the U.S. by $572. At the same time, the shock reduced annual rent per worker by $109 in the short run and by $146 in the medium run.[34] Again, the medium-run effects are more negative than the short-run effects due to the persistent decline in rental prices.

4.5 Total Impact on Standards of Living

The total national-level effects are given by the sum of the dollar value of the direct and indirect effects, which amount to a $3264 rise in income per worker (in 2012 $) and a net decline in rent per worker (in 2012 $) of $550 over the medium run (1970-1990). This combination of an average rise in incomes along with a simultaneous average fall in rents is an important outcome associated with the kinked housing supply function: while in any particular market incomes and rents are likely to be positively correlated (as implied by Figure 1), the fact that import shocks can disproportionately reduce rents in some markets led to an average fall in rents despite the average rise in income. Here we evaluate the consequences of this for standards of living by also incorporating differences in home ownership rates across labor markets as a source of heterogeneity, following the discussion in Section 4.1.5. As discussed there, while a local rise in home or rental prices represents a *gain* for incumbent

geographic detail on migration). Our gravity regression includes bilateral distance, origin population, destination population, an indicator for sharing a border, and economic distance based on a measure of industrial similarity. The R-squared from this regression is 0.73. We then use the coefficients from this MSA-level regression to predict the general bilateral migration patterns across labor markets. We use MSA flows because, unfortunately, county-to-county migration data (that we could aggregate to the labor market level) is not available until 2005, and these recent migration patterns would be endogenous to our shocks. Clearly the shortcoming of this approach is that the determinants of migration patterns across MSAs may not exactly match the determinants across labor markets, but we find that our calculations of the indirect effects are not very sensitive to the exact sizes of the gravity coefficients.

[33] This assumes an average labor share of 0.65 and flexible capital share of 0.20. The notion that the labor demand elasticity is uniform across labor markets is of course stylized (e.g., see Monte et al. (2018)), but its estimation at the labor market level during our period is beyond the scope of this paper.

[34] We set aside the effect on home values here in part due to the fact that the change in rental prices is the key determinant of the purchasing power impact and in part due to the subtlety in interpretation of home value impacts on purchasing power discussed in Section 4.1.5 above.

home and property owners, it represents a *loss* for non-incumbent home buyers or renters. As a result, high (low) home-ownership rates in a local labor market will lead to on-average gains (losses) due to export exposure and on-average losses (gains) due to import exposure. Figure 7 maps home-ownership rates at the beginning of the container shock in 1970 across U.S. counties, where we see that there was indeed wide variation in the prevalence of home ownership. For instance, only 14 percent of homes in the Bronx were owner occupied in 1970, whereas many Michigan counties were above 80 percent. We calculate the aggregate impact on each labor market as the weighted average of outcomes for home owners and renters, where the weights are the rates of home ownership and renting in 1970 (see Figure 7). The outcomes for home owners that we present are calculated for the case in which home owners completely liquidate their gains (see Section 4.1.5).

To summarize our approach thus far, the total incidence of the trade shock will vary across labor markets for three primary reasons: 1) the magnitude of exposure to the export and import shocks will vary; 2) the local housing supply elasticity will vary; and 3) the share of incumbent home owners versus non-incumbent home owners and renters will vary. These factors will independently generate concentration of the effects in certain markets, but this concentration will be further exacerbated due to systematic correlation in these factors across markets. In fact, both export and import exposure are strongly, positively correlated with home ownership rates, a byproduct of the fact that manufacturing was relatively concentrated in the Midwest. Additionally, home ownership is generally more prevalent in areas that have more available land – i.e., a larger housing supply elasticity. Taken together, these correlations have important implications for the geography of the response of housing markets to shocks. For instance, in places with relatively large housing supply elasticities and high home ownership (e.g., the Great Lakes region) an export shock will lead to relatively large average gains due to high home ownership, but these gains will dissipate relatively quickly due to the large local supply elasticity (as indicated by the estimates in Table 11). Thus, in the long run these two features work in opposite directions in their influence on the local incidence of the trade shock. At the other extreme, in places with small housing supply elasticities and low home ownership (e.g., San Francisco) an export shock will lead to relatively large average losses in the housing market since most people are renters, and this effect is more likely to persist due to the small local supply elasticity (again see Table 11). This leads to an exacerbated, negative long-run welfare impact via the housing market – though it is important to note that positive income effects may offset this loss. Finally, since the impact of import exposure is invariant to the local housing supply elasticity (Table 11), the prevalence of home ownership and the magnitude of the trade shock solely determine the geography of import effects.

Table 12 lists the CZs with the largest dollar value rise in standard of living (top panel) and those with the largest fall in standard of living (bottom panel), along with a decomposition into direct and indirect effects in columns (1)-(3). We denote the CZ by its largest MSA. We also list the percentile of each labor market in the distribution of trade shock magnitudes, housing supply elasticities, and home ownership rates in columns (4)-(7). The broad picture that emerges in the top panel is that the largest gains accrued to CZs that experienced relatively large export shocks, had relatively low housing supply elasticities, and had relatively high home ownership rates. In these areas labor demand rose due to high export exposure, but the relatively low housing supply elasticities limited the amount of new home building which led to relatively large increases in home and rental prices. High home ownership rates then ensured these gains accrued, on average, to the majority of residents. A contrasting story is evident in the bottom panel: high import exposure combined with relatively high home ownership rates meant that property value declines accrued to the majority of residents. Note that in this case the housing supply elasticities are in some cases quite high, and in other cases quite low, consistent with our model and findings in which the effects of import competition are invariant to local supply elasticities since the supply elasticity is uniformly near zero across markets.

Overall, we see that the purchasing power outcomes due to the containerization-induced trade shock varied widely across labor markets. The effects were dominated by the direct effects, though indirect effects were of important magnitude. And consistent with other parts of the literature we see that the Midwest was most negatively impacted.

5 Concluding Remarks

We exploit exogenous variation in container port openings to measure the impact of the second wave of globalization on U.S. welfare. There are three main contributions of this work. First, we carefully construct measures of exposure to growing import and export markets and identify their differential effects on income, employment and home and rental prices. Second, we leverage the study's focus on a historical technological development in goods transport by presenting results across three decades. Previous work has mostly focused more narrowly on short-run impacts, typically with a focus on import shocks. Lastly, we present a theoretical and empirical analysis of the housing market response to a trade shock that incorporates asymmetry in the housing supply function. This allows us to focus on heterogeneity in the effects of trade shocks across locations which highlighted some interesting disparities. For example, areas such as the rust belt used to be centers of well-paying blue-collar jobs. Import competition from the 1970s onwards, along with high homeownership rates that had previously served as symbols of prosperity, led to persistent declines in home values that eroded average standards of living.

The findings highlight the importance of accounting for the housing market in evaluating the welfare consequences of trade at the local level. The magnitude of the outcome gaps arising from asymmetry in the housing supply response indicate that future work should be cognizant of this housing market dynamic.

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Figure 1: Housing Demand and Supply with Asymmetric Housing Supply Costs

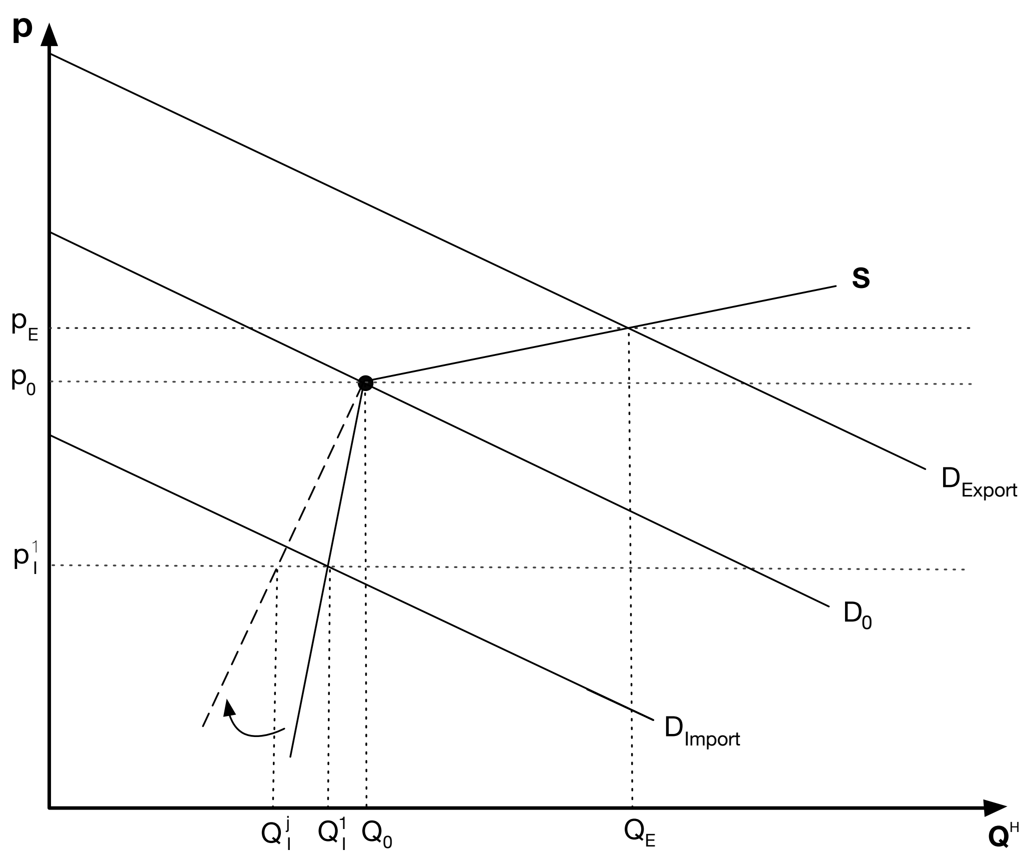


Figure 2: U.S. Merchandise Trade as a Share of GDP

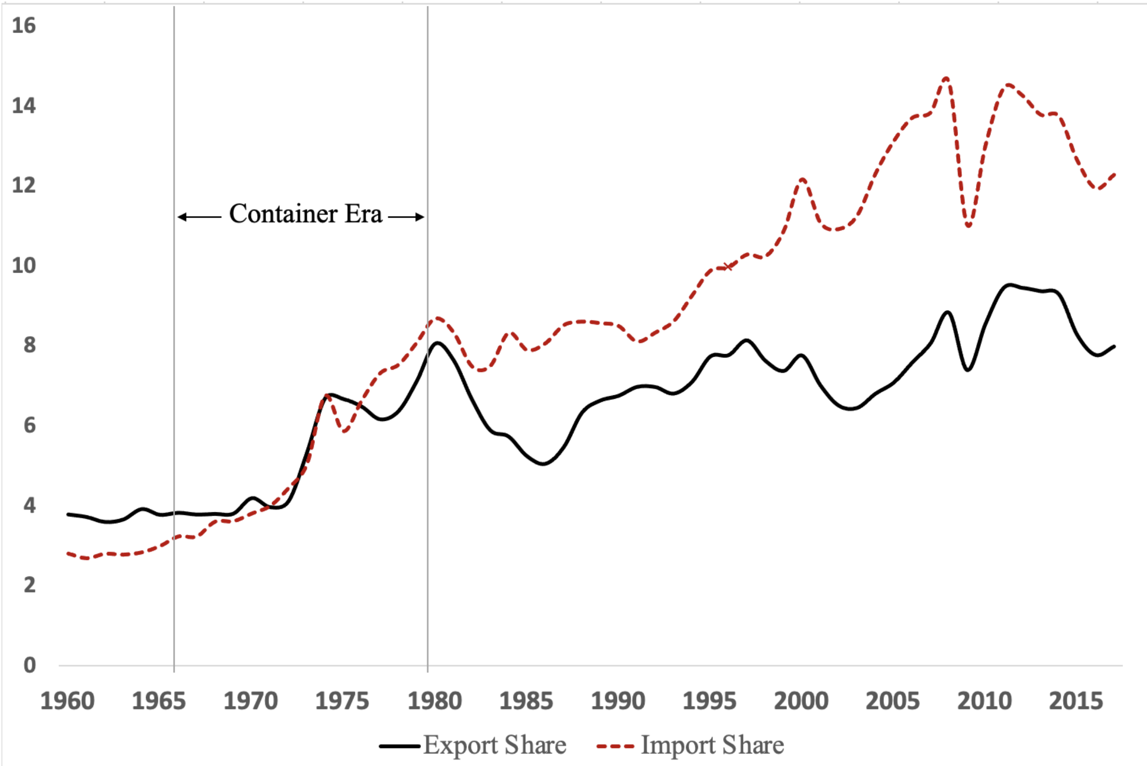
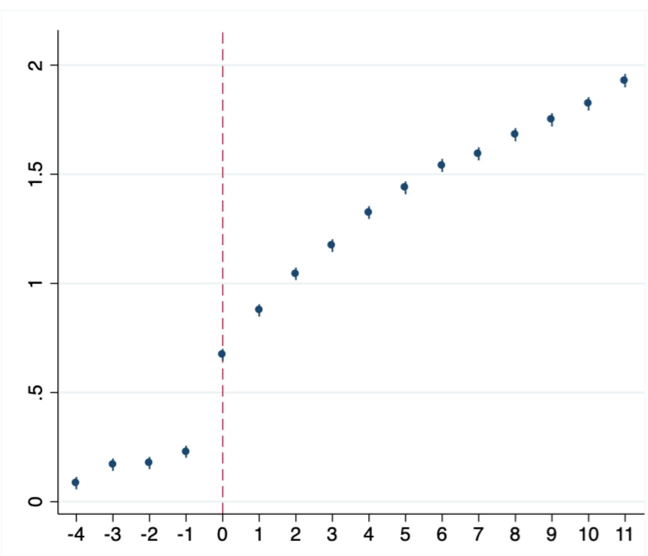
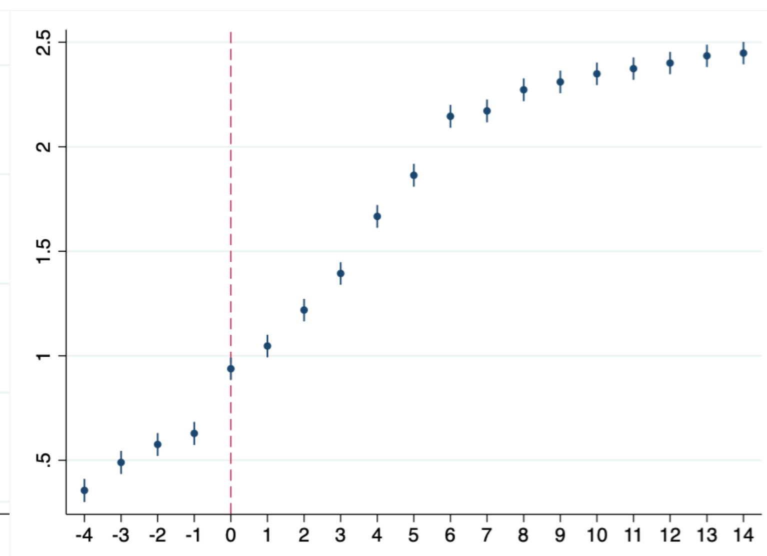


Figure 3: Port Adoption Treatment Effects on Log Bilateral Exports and Imports



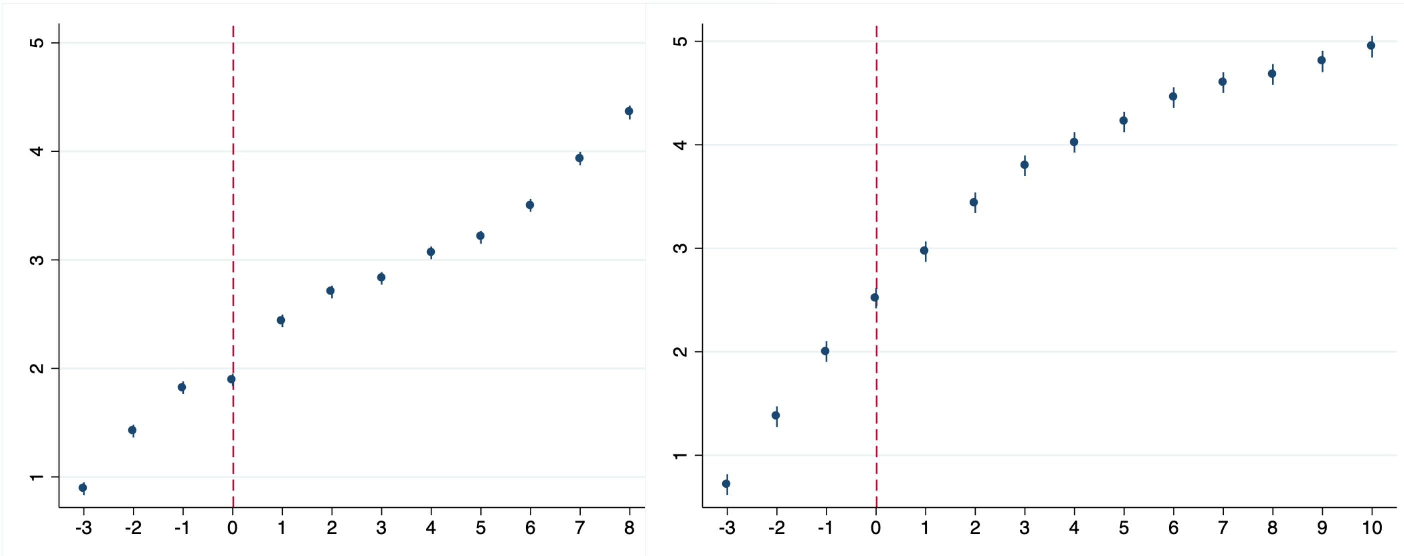
(a) Exports Trajectory



(b) Imports Trajectory

Note: The figure plots the coefficients of a regression of log *containerizable* exports or imports on an indicator (0,1) for whether a country adopted container-friendly port technologies in a given year.

Figure 4: Placebo Treatment Effects on Log Bilateral Exports and Imports

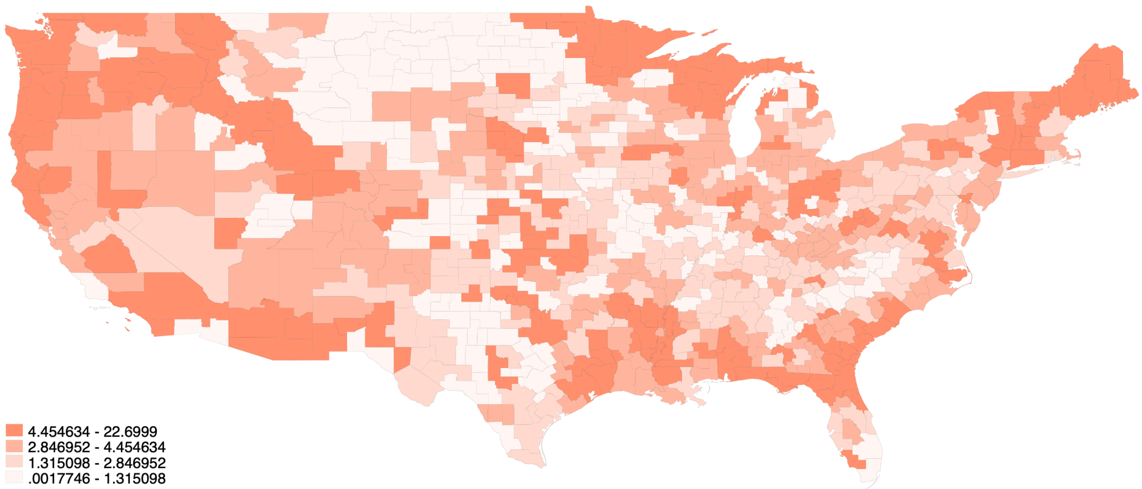


(a) Exports Trajectory **(b) Imports Trajectory**

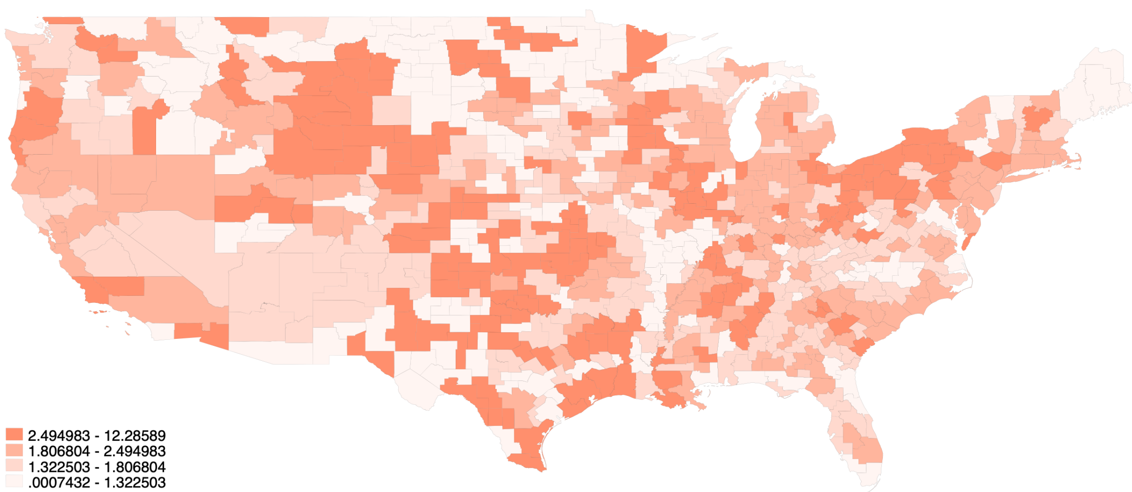
Note: The figure plots the coefficients of a regression of log *non-containerizable* exports or imports on an indicator (0,1) for whether a country adopted container-friendly port technologies in a given year.

Figure 5: Distribution of Export and Import Exposure Over the Period 1966 to 1980

(a) Export Exposure



(b) Import Exposure



Note: The figures map the values of the export and import exposure measures covering 1966-1980 across U.S. Commuting Zones, as defined by (2) and (3).

Figure 6: Foreign Container Port Openings and U.S. Bilateral Trade with Partner Countries

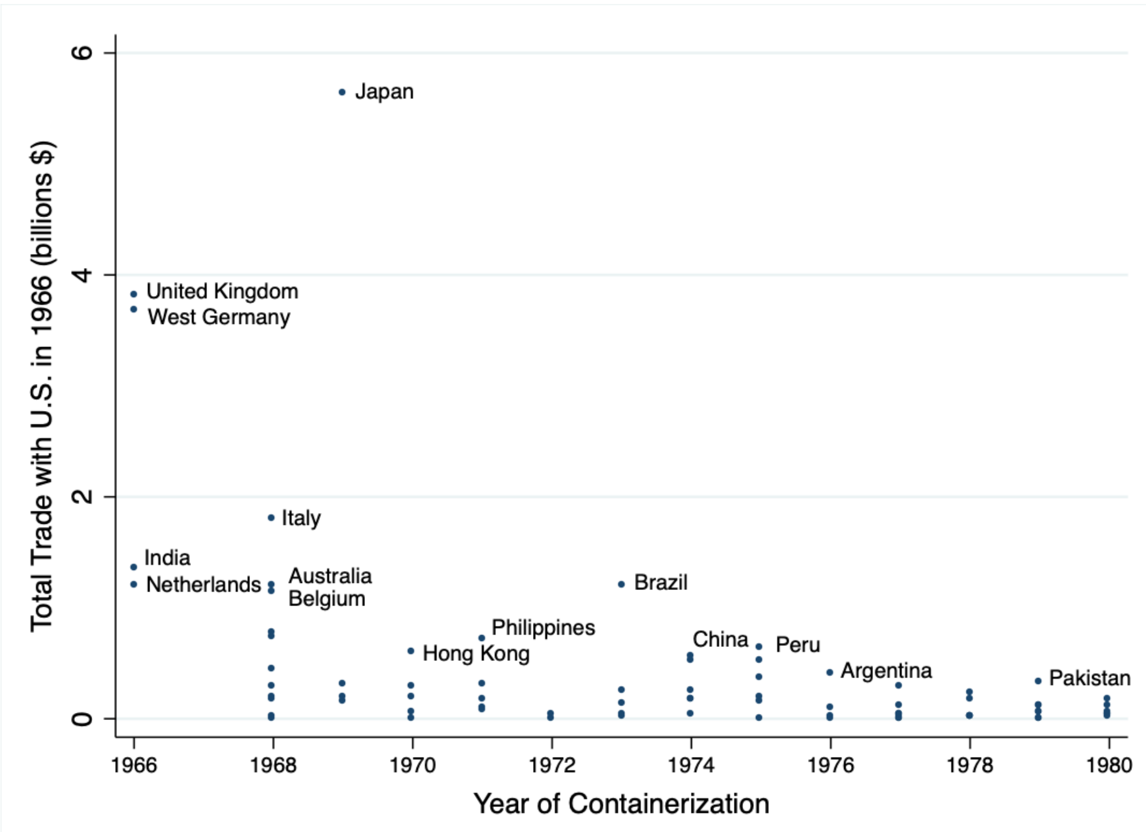


Figure 7: Home Ownership Rates Across U.S. Counties, 1970

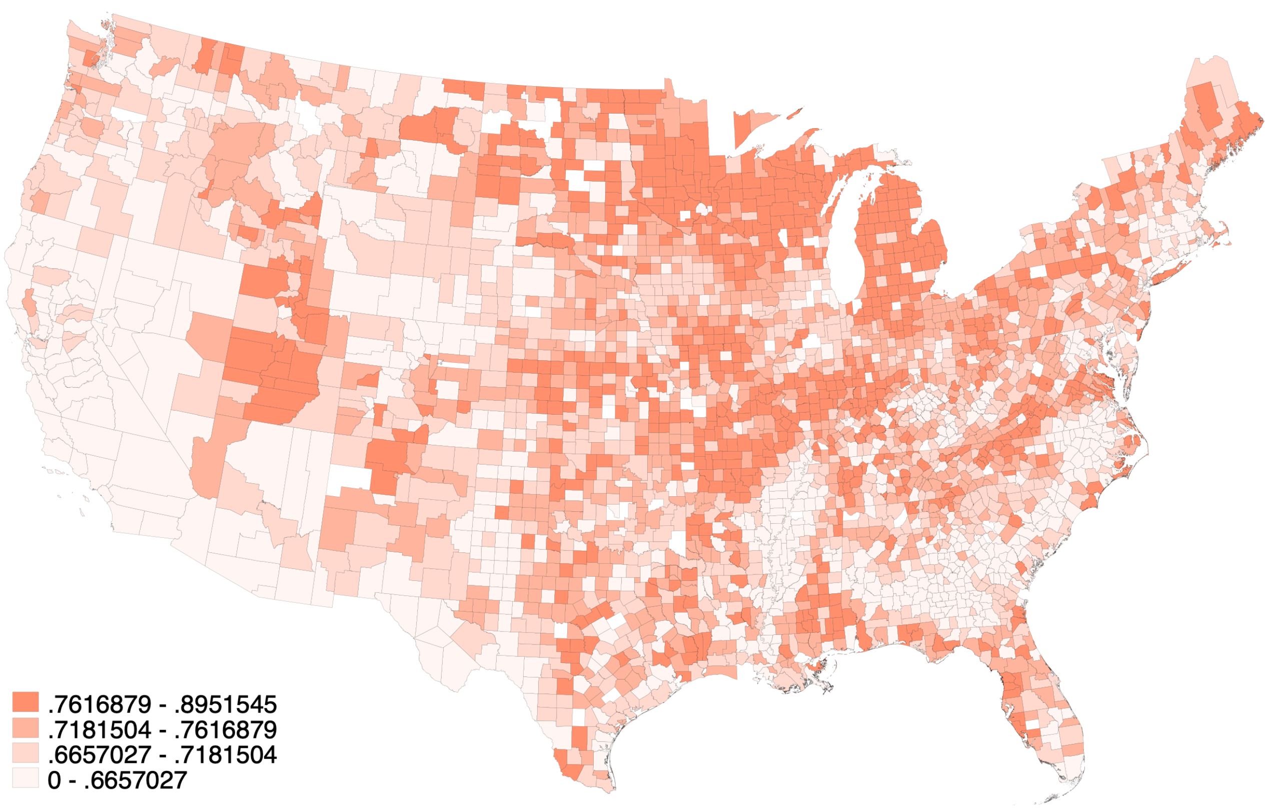


Table 1: Summary Statistics at the Commuting Zone Level

	Observations Per Decade	1966-1980 Mean/S.D.	1966-1980 Median	1970-1980 Mean/S.D.	1980-1990 Mean/S.D.	1990-2000 Mean/S.D.
100 × △ in Export Exposure	722	2.02	1.19			
		(2.89)				
100 × △ in Import Exposure	722	2.24	1.26			
		(3.13)				
100 × Log △ in Total Employment	722			24.43	18.12	18.54
				(14.04)	(12.16)	(13.28)
100 × Log △ in Mfg Employment	722			11.86	-6.91	-3.52
				(8.85)	(6.82)	(5.07)
100 × Log △ in Non-Mfg Employment	722			24.37	19.02	19.34
				(13.32)	(11.05)	(12.97)
100 × Log △ in Home Prices (2012 $)	722			27.30	16.54	6.23
				(23.32)	(16.05)	(15.57)
100 × Log △ in Rental Prices (2012 $)	722			22.04	20.76	4.92
				(31.09)	(27.82)	(14.76)
100 × Log △ in Income (2012 $)	722			6.88	7.70	11.59
				(9.03)	(11.21)	(14.81)

Notes: The table reports summary statistics for the main independent variables over the period of the shock (1966-1980) and for the main dependent variables for each decade individually. Total employment is total non-farm employment.

Table 2: Predicted Exports and Imports

	Log Exports				Log Imports			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Port-Rail Indicator	0.122***	1.387***	2.764***	2.477***	2.261***	1.753***	1.977***	2.278***
	(0.0138)	(0.0310)	(0.207)	(0.189)	(0.0730)	(0.0642)	(0.555)	(0.500)
Log Distance		-0.641***	-0.920***	-1.063***		-0.143***	-0.356***	-0.197***
		(0.0299)	(0.0320)	(0.0278)		(0.0507)	(0.0617)	(0.0536)
Log Tariff		0.113***	0.429***	0.440***		-0.0690	-0.0185	0.113
		(0.0332)	(0.0421)	(0.0390)		(0.0496)	(0.0807)	(0.0755)
Colonized		0.404***	2.047***	2.085***		0.333***	1.361***	1.568***
		(0.0321)	(0.0620)	(0.0535)		(0.0476)	(0.102)	(0.0916)
Common Language		0.505***	0.447***	0.568***		-0.123***	-0.298***	-0.307***
		(0.0193)	(0.0222)	(0.0192)		(0.0361)	(0.0454)	(0.0379)
Third-Country Exports to j		5.22e-08***	5.18e-08***	5.59e-08***				
		(1.23e-09)	(1.15e-09)	(1.11e-09)				
Third-Country Exports to *U.S.*						2.01e-08***	2.94e-08***	2.62e-08***
						(9.02e-10)	(9.51e-10)	(9.72e-10)
Third-Country TFP		0.181***	0.245***	0.326***		-0.623***	-0.555***	-0.487***
		(0.0276)	(0.0276)	(0.0275)		(0.0710)	(0.0708)	(0.0634)
Port-Rail x Distance			0.974***	1.071***			0.420***	0.416***
			(0.0248)	(0.0220)			(0.0600)	(0.0526)
Port-Rail x Tariff			-0.500***	-0.475***			-0.123*	-0.0402
			(0.0292)	(0.0273)			(0.0677)	(0.0655)
Port-Rail x Language			0.0253	-0.0327			0.281***	-0.0660*
			(0.0275)	(0.0252)			(0.0442)	(0.0387)
Port-Rail x Colonized			-1.930***	-1.985***			-1.221***	-0.838***
			(0.0501)	(0.0445)			(0.0879)	(0.0831)
Observations	439707	439707	439707	439707	145350	142205	142205	142205
Product and Year FE	no	no	no	yes	no	no	no	yes
Adjusted R^2	.147	.221	.232	.429	.175	.245	.248	.402

Notes: The table reports the results from specification (6) along with a symmetric version for imports. The coefficients on variables involving the Port-Rail indicator are then used to generate predicted imports and exports, which are then used to construct the IVs.

Table 3: Pre-Period Trends in Trade and the Timing of Port Containerization

	MAIN SPECS		EARLY ADOPTER		LATE ADOPTER		RELIANT ON U.S.		NOT RELIANT ON U.S.	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Import Growth	-0.00458		-0.00368		-0.00414		0.0000377		-0.00724	
	(0.00454)		(0.0288)		(0.00428)		(0.00963)		(0.00452)	
Export Growth		0.00374		-0.00545		0.00313		-0.00314		0.00547
		(0.00459)		(0.0126)		(0.00416)		(0.0108)		(0.00400)
N	3933	4342	1104	1102	2829	3240	2325	2358	1608	1984
Country FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Notes: The dependent variable is an indicator for the opening of a foreign container port. The regressors are import and export growth in the 5-year period prior to the port opening.

Table 4: First Stage

	Export Exposure	Import Exposure
Predicted Export Exposure	0.535***	-0.003
	(0.005)	(0.007)
Predicted Import Exposure	-0.005*	0.826***
	(0.003)	(0.003)
Manufacturing Share	-0.002***	-0.003***
	(0.000)	(0.000)
Employment Pre-Trends	-0.001	0.001
	(0.000)	(0.000)
Observations	721	721
K-P Wald F-Statistic	37.94	37.94

Notes: The table reports first stage results of export and import exposure on their predicted exposures and controls. Predicted exposure is constructed as described in Section 2.2.1.

Table 5: Trade Exposure and Housing Supply

	1970-1980	1970-1990	1970-2000	1970-1980	1970-1990	1970-2000
	(1)	(2)	(3)	(4)	(5)	(6)
		OLS			2SLS	
Export Exposure	5.048**	6.194	6.576	7.491**	7.290	9.311
	(2.430)	(5.733)	(11.803)	(3.938)	(10.338)	(13.536)
Import Exposure	-1.080	-1.694	0.344	-2.310	-1.567	-1.307
	(4.520)	(4.603)	(1.767)	(2.853)	(1.294)	(1.993)
Manufacturing Share	-0.003*	-0.001*	-0.000	0.001	0.001	0.002
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Pre-Trend in Housing Supply	0.428	0.215	0.197	0.401	0.388	0.210
	(0.618)	(0.433)	(0.328)	(0.315)	(0.506)	(0.200)
Observations	722	722	722	722	722	722
State FE	✓	✓	✓	✓	✓	✓

Notes: The table reports estimates of the cumulative effects from specification (1). The dependent variable is 100 × the change in log total housing units in a commuting zone (labor market) over the period noted (1970-1980, 1970-1990, 1970-2000). The regressors include 100 × import and export exposure as defined in equations (2) and (3) in the text. We control for pre-trends in the outcome variable and the manufacturing share of employment. Standard errors are clustered at the labor market level. *** Significant at the 1 percent, ** 5 percent, * 10 percent level.

Table 6: Trade Exposure and Employment Growth

	1970-1980	1970-1990	1970-2000	1970-1980	1970-1990	1970-2000
	(1)	(2)	(3)	(4)	(5)	(6)
		OLS			2SLS	
Export Exposure	3.309**	3.173	2.229	4.750*	5.030	5.751
	(1.731)	(2.506)	(3.198)	(3.002)	(4.737)	(4.732)
Import Exposure	-1.316**	-1.740*	-2.379	-2.134**	-2.722	-3.047
	(0.655)	(0.914)	(2.199)	(1.161)	(1.748)	(3.767)
Manufacturing Share	-0.004	0.005	0.005	0.002	0.002	0.002
	(0.005)	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)
Pre-Trend in Employment	0.610	0.402	0.412*	0.663	0.419	0.352
	(0.663)	(0.394)	(0.228)	(0.384)	(0.385)	(0.302)
Observations	722	722	722	722	722	722
State FE	✓	✓	✓	✓	✓	✓

Notes: The table reports estimates of the cumulative effects from specification (1). The dependent variable is 100 × the change in log employment in a commuting zone (labor market) over the period noted (1970-1980, 1970-1990, 1970-2000). The regressors include 100 × import and export exposure as defined in equations (2) and (3) in the text. We control for pre-trends in the outcome variable and the manufacturing share of employment. Standard errors are clustered at the labor market level. *** Significant at the 1 percent, ** 5 percent, * 10 percent level.

Table 7: **Trade Exposure and Employment Growth by Sector, 2SLS Only**

	1970-1980	1970-1990	1970-2000	1970-1980	1970-1990	1970-2000
	(1)	(2)	(3)	(4)	(5)	(6)
	Manufacturing, 2SLS			**Non-Manufacturing, 2SLS**		
Export Exposure	6.203***	6.638*	6.814	2.070*	2.347	3.524
	(2.273)	(4.112)	(4.922)	(1.239)	(1.782)	(5.140)
Import Exposure	-3.374***	-2.748	-4.385	-1.383**	-1.625	-3.561
	(1.059)	(2.353)	(3.039)	(0.779)	(1.853)	(4.208)
Manufacturing Share	-0.003	0.004	0.005	-0.006	0.002	0.002
	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)
Pre-Trend in Employment	0.471	0.429	0.512	0.338**	0.291	0.117
	(0.477)	(0.538)	(0.409)	(0.110)	(0.447)	(0.206)
Observations	722	722	722	722	722	722
State FE	✓	✓	✓	✓	✓	✓

Notes: The table reports 2SLS estimates of the cumulative effects from specification (1), separately for the Manufacturing sector (left) and the Non-manufacturing sector (right). The dependent variable is 100 × the change in log employment in a commuting zone (labor market) over the period noted (1970-1980, 1970-1990, 1970-2000). The regressors include 100 × import and export exposure as defined in equations (2) and (3) in the text. We control for pre-trends in the outcome variable and the manufacturing share of employment. Standard errors are clustered at the labor market level. *** Significant at the 1 percent, ** 5 percent, * 10 percent level.

Table 8: Trade Exposure and Income Growth

	1970-1980	1970-1990	1970-2000	1970-1980	1970-1990	1970-2000
	(1)	(2)	(3)	(4)	(5)	(6)
	OLS			**2SLS**		
Export Exposure	3.727***	2.382	2.022	4.663**	3.601	3.321
	(1.084)	(2.441)	(2.606)	(2.642)	(3.062)	(3.235)
Import Exposure	-1.534***	-0.948	-0.576	-1.925**	-1.263	-0.893
	(0.892)	(0.991)	(1.001)	(1.161)	(1.748)	(3.767)
Manufacturing Share	-0.004*	-0.001	-0.000	0.002	0.002	0.002
	(0.002)	(0.001)	(0.001)	(0.003)	(0.003)	(0.003)
Pre-Trend in Income	0.209	0.199	0.173	0.334	0.251	0.211
	(0.213)	(0.305)	(0.207)	(0.392)	(0.282)	(0.301)
Observations	722	722	722	722	722	722
State FE	✓	✓	✓	✓	✓	✓

Notes: The table reports estimates of the cumulative effects from specification (1). The dependent variable is 100 × the change in log median income in a commuting zone (labor market) over the period noted (1970-1980, 1970-1990, 1970-2000). Values are in 2012 $. The regressors include 100 × import and export exposure as defined in equations (2) and (3) in the text. We control for pre-trends in the outcome variable and the manufacturing share of employment. Standard errors are clustered at the labor market level. *** Significant at the 1 percent, ** 5 percent, * 10 percent level.

Table 9: Trade Exposure and Home Price Growth

	1970-1980	1970-1990	1970-2000	1970-1980	1970-1990	1970-2000
	(1)	(2)	(3)	(4)	(5)	(6)
	OLS			2SLS		
Export Exposure	2.928***	4.359	4.023	4.243***	5.531	4.692
	(1.078)	(4.285)	(5.338)	(2.603)	(3.991)	(5.700)
Import Exposure	-2.245***	-4.246**	-4.105	-5.201***	-5.912**	-6.889
	(0.679)	(2.535)	(4.095)	(2.003)	(2.991)	(7.804)
Manufacturing Share	0.003	0.002*	0.000**	0.002	0.002	0.001
	(0.002)	(0.001)	(0.000)	(0.003)	(0.003)	(0.003)
Pre-Trend in Home Prices	0.522	0.419	0.400	0.691	0.406*	0.381*
	(0.442)	(0.491)	(0.504)	(0.551)	(0.293)	(0.185)
Observations	722	722	722	722	722	722
State FE	✓	✓	✓	✓	✓	✓

Notes: The table reports estimates of the cumulative effects from specification (1). The dependent variable is 100 × the change in log median home price in a commuting zone (labor market) over the period noted (1970-1980, 1970-1990, 1970-2000). Values are in 2012 $. The regressors include 100 × import and export exposure as defined in equations (2) and (3) in the text. We control for pre-trends in the outcome variable and the manufacturing share of employment. Standard errors are clustered at the labor market level. *** Significant at the 1 percent, ** 5 percent, * 10 percent level.

Table 10: Trade Exposure and Rental Price Growth

	1970-1980	1970-1990	1970-2000	1970-1980	1970-1990	1970-2000
	(1)	(2)	(3)	(4)	(5)	(6)
	OLS			2SLS		
Export Exposure	2.235**	2.413*	3.807	3.778**	4.259	4.025
	(1.214)	(1.405)	(3.424)	(2.038)	(3.438)	(5.536)
Import Exposure	-3.080***	-3.694**	-4.444	-4.216**	-6.211**	-5.307
	(1.366)	(2.319)	(3.664)	(2.515)	(3.388)	(4.558)
Manufacturing Share	0.002**	0.002	0.002	0.002	0.002	0.002
	(0.001)	(0.001)	(0.002)	(0.003)	(0.003)	(0.003)
Pre-Trend in Rents	0.491	0.303	0.217	0.552	0.462*	0.280
	(0.454)	(0.398)	(0.333)	(0.485)	(0.302)	(0.199)
Observations	722	722	722	722	722	722
State FE	✓	✓	✓	✓	✓	✓

Notes: The table reports estimates of the cumulative effects from specification (1). The dependent variable is 100 × the change in log median rental price in a commuting zone (labor market) over the period noted (1970-1980, 1970-1990, 1970-2000). Values are in 2012 $. The regressors include 100 × import and export exposure as defined in equations (2) and (3) in the text. We control for pre-trends in the outcome variable and the manufacturing share of employment. Standard errors are clustered at the labor market level. *** Significant at the 1 percent, ** 5 percent, * 10 percent level.

Table 11: **Trade Exposure and Outcomes, By Land Unavailability (2SLS Only)**

	1970-1980	1970-1990	1970-2000	1970-1980	1970-1990	1970-2000
	(1)	(2)	(3)	(4)	(5)	(6)
PANEL A Dep Var: Log △ Housing Supply	**High Availability**			**Low Availability**		
Export Exposure	8.183**	8.859**	8.025	2.008	1.631	2.291
	(4.038)	(5.238)	(7.536)	(2.510)	(3.370)	(4.091)
Import Exposure	-0.824	-1.225	-1.047	-2.723	-2.916	-2.992
	(1.166)	(1.519)	(2.664)	(2.515)	(2.388)	(2.558)
Manufacturing Share	0.002	0.001	-0.001	0.002	0.002	0.002
	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)	(0.004)
Pre-Trend in Housing Supply	0.658**	0.639*	0.585	0.511	0.492	0.442
	(0.320)	(0.421)	(0.481)	(0.496)	(0.548)	(0.580)
PANEL B Dep Var: Log △ Home Prices	**High Availability**			**Low Availability**		
Export Exposure	2.074**	3.293	4.718	4.005**	4.833*	5.519
	(1.139)	(2.629)	(4.062)	(2.283)	(2.915)	(5.552)
Import Exposure	-4.285***	-4.791	-6.623	-6.027**	-6.311*	-7.048
	(2.010)	(3.862)	(5.792)	(3.577)	(4.239)	(9.451)
Manufacturing Share	0.002	0.002	0.001	0.002	0.003	0.003
	(0.002)	(0.001)	(0.001)	(0.003)	(0.003)	(0.003)
Pre-Trend in Home Prices	0.500	0.432	0.308	0.441	0.372	0.351
	(0.621)	(0.305)	(0.207)	(0.392)	(0.282)	(0.301)
PANEL C Dep Var: Log △ Housing Rent	**High Availability**			**Low Availability**		
Export Exposure	4.109**	4.449	6.027	5.113**	5.736*	5.725
	(2.184)	(3.651)	(4.629)	(2.480)	(3.172)	(5.728)
Import Exposure	-3.201***	-4.415	-5.021	-4.620***	-4.309**	-6.912
	(1.003)	(3.361)	(4.107)	(1.660)	(2.076)	(8.824)
Manufacturing Share	0.001	0.001	0.001	0.002	0.002	0.003
	(0.002)	(0.001)	(0.001)	(0.003)	(0.003)	(0.003)
Pre-Trend in Rents	0.620*	0.492	0.441	0.591	0.558	0.414
	(0.447)	(0.426)	(0.422)	(0.529)	(0.561)	(0.587)
Observations	361	361	361	361	361	361
State FE	✓	✓	✓	✓	✓	✓

Notes: The table reports 2SLS estimates from three separate specifications given by (1), where the outcomes are listed at the top of each panel and the estimates are reported for high availability (below median land unavailability) and low availability (above median land unavailability). The land unavailability measure is described in Section 4.3. The dependent variable is 100 × the change in log outcome in a commuting zone (labor market) over the period noted (1970-1980, 1970-1990, 1970-2000). The regressors include 100 × import and export exposure as defined in equations (2) and (3) in the text. We control for pre-trends in the outcome variable and the manufacturing share of employment in all specifications. Standard errors are clustered at the labor market level. *** Significant at the 1 percent, ** 5 percent, * 10 percent level.

Table 12: Largest Purchasing Power Gains and Losses by Commuting Zone

Commuting Zone (Largest MSA)	△ Total PP ($)	△ Direct PP ($)	△ Indirect PP ($)	Pctile Export Exposure	Pctile Import Exposure	Pctile Supply Elasticity	Pctile Home Own. Rate
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Largest Purchasing Power Gains							
Charlotte-Gastonia-Rock Hill NC-SC	8811	6612	2199	82	50	17	68
Houston TX PMSA	8105	6008	2097	91	38	34	81
Mobile AL MSA	7004	5237	1767	85	71	48	73
Hartford CT NECMA	6914	5019	1895	69	62	5	82
Pittsfield MA NECMA	6259	4581	1678	98	49	51	91
Los Angeles-Long Beach CA PMSA	6251	4223	2028	94	16	62	58
Atlanta GA MSA	4926	3408	1518	90	90	28	64
Phoenix-Mesa AZ MSA	4751	3127	1624	73	36	43	93
Beaumont-Port Arthur TX MSA	4662	2982	1680	65	58	57	91
Rochester MN MSA	4410	2955	1455	88	82	59	98
Largest Purchasing Power Losses							
Cleveland-Lorain-Elyria OH PMSA	-6061	-4337	-1724	47	92	25	59
Toledo OH MSA	-5801	-4099	-1702	61	94	34	68
Fort Smith AR-OK MSA	-5763	-3895	-1868	24	74	68	58
Dayton-Springfield OH MSA	-5691	-3857	-1834	21	89	45	72
Grand Rapids-Muskegon-Holland MI	-5602	-3904	-1698	48	72	60	80
Detroit MI PMSA	-5225	-3624	-1601	62	65	85	67
Cincinnati OH-KY-IN PMSA	-4337	-2781	-1556	33	79	34	59
Birmingham-Hoover, AL MSA	-3912	-2403	-1509	25	63	81	87
Pittsburgh PA MSA	-3904	-2381	-1523	52	68	41	70
Columbus OH MSA	-3770	-2004	-1766	70	94	39	72

Notes: The table reports values for twenty Commuting Zones (CZs), where the CZs are named according to the largest MSA in the CZ. PP indicates Purchasing Power, which is calculated as in Section 4.1.5 as: (dollar growth in income) − (dollar growth in rental prices) − (dollar growth in non-housing prices). We calculate purchasing power for home owners for the scenario in which they fully liquidate their gains or losses. The total effect for a CZ is the weighted combination of purchasing power outcomes for home owners and renters, using home ownership and rental rates as weights. The top panel reports values for the CZs experiencing the largest gains in PP and the bottom panel for those experiencing the largest declines in PP. PP changes are in 2012 dollars.

A A Model of Housing Markets and Trade

In this section we describe a simple spatial equilibrium model of a labor market in which homes are situated along a line at some distance to a central business district (CBD), as in Solow (1973). Each home is associated with a single worker who migrates across labor markets in response to shocks up to the point that the worker's reservation utility $\bar{U}$ is equalized across markets. Each worker must commute to the CBD for work, incurring a cost T times the distance to work. Within the labor market, housing rental prices will be such that the commuting cost that each worker pays perfectly offsets the annual rent $r(d)$ incurred while living a distance d from the CBD, such that $r(d) + Td = r(0)$. Across labor markets, in order to maintain a constant reservation utility, wages w must be set so that $w - \bar{U} = r(d) + Td$ at every distance d from the CBD. In other words, the sum of commuting costs and rental prices must always be just offset by wages. We define $\omega \equiv w - \bar{U}$ as the normalized wage.

Following Glaeser and Gyourko (2005), we model home depreciation by assuming that in each period a random fraction δ of homes collapses and is rebuilt only as long as the expected rental flows from the home exceed the cost C of construction.[35] This implies that at time $t + j$ it must be the case that for the marginal home under construction $C = E_t\left(\sum_{j\geq 0} \frac{(1-\delta)^j r_{t+j}(d)}{(1+\rho)^j}\right)$, where ρ is the discount rate. If we further assume that ω follows a random walk, so that $E_t(\omega_{t+j}) = \omega_t$, then combined with the wage setting equation from above this can be rewritten as $C = \left(\frac{1+\rho}{\delta+\rho}\right)(\omega_t - Td)$. This condition defines the outermost edge of the labor market, from which it follows that homes will only be built at distances d that are less than $\frac{\omega_t}{T} - \left(\frac{\delta+\rho}{1+\rho}\right)C$.

We can use this framework to explore the link between global trade shocks and local labor and housing market outcomes. In short, we can think of a trade shock as altering the demand for local output and, hence, the demand for local workers. Specifically, foreign productivity shocks or reductions in bilateral trade costs may lead to a supply-driven rise in foreign exports to the markets in which U.S. and foreign firms compete. This will tend to reduce the demand for U.S. workers, particularly for those working in labor markets that sell more in those markets. At the same time, it may also lead to a demand-driven increase in foreign imports from some U.S. labor market that will tend to increase the demand for U.S. workers in that market. Autor et al. (2013) describe a general equilibrium model with these features and show how equilibrium wages in a labor market can be written as a function of local trade exposure.[36]

[35] Related parts of the literature include Kenny (2003), who models asymmetric adjustment costs in housing production but is concerned with adjustment in housing construction flows, not stocks. Flavin and Nakagawa (2008) incorporate adjustment costs into consumers' housing purchase decision, but do not model the supply decision.

[36] That model includes two tradeable differentiated-goods sectors and a non-tradable sector. Differential productivity growth, or trade cost reductions, in the two tradable sectors in the foreign country (e.g., China) lead to reallocations of labor across the sectors in the home country local labor market. When the local labor market has a trade imbalance (expenditure and income diverge in the labor market) then there is labor reallocation across tradeables and non-tradeables as well, a prediction we find evidence for in Section 4.1.1. They show that for labor market i and industry j, the local change in wages ($\hat{W}$) due to imports from China (C) is given by $\hat{W}_i = \sum_j c_{ij} \frac{L_{ij}}{L_{Ni}} \left[\theta_{ijC}\hat{E}_{Cj} - \sum_k \theta_{ijk}\phi_{Cjk}\hat{A}_{Cj}\right]$ where L is employment, E is expenditure, A is supply capability and N represents the non-traded sector. Our trade exposure measures derived in Section 3.1 below are consistent with this equilibrium condition.

This is the framework we have in mind here, in which local labor markets are differentially exposed to import and export shocks leading to a net inward or outward shift in the demand for labor and, ultimately, housing. Formally, we assume that a trade shock in some local labor market leads to a shift in the normalized wage from ω to $\omega' = \omega + \triangle$. Figure 1 depicts this shift and the subsequent reaction of housing markets. When $\triangle > 0$, wages rise and workers migrate in from surrounding labor markets. As a result, the local demand for housing rises. Since the housing supply curve is relatively elastic above current supply, this leads to new home construction and an increase in housing units equal to $\frac{2\triangle}{T}$ (the movement from Q_0 to Q_E in Figure 1). In contrast, housing supply is inelastic below current supply so that when $\triangle < 0$ the housing supply falls only by the rate of depreciation in each period (represented by the rotation of the supply curve below Q_0), and fewer workers migrate out of the labor market. In the first period following the shock the housing supply falls by $\frac{2\delta\triangle}{T}$ (Q_0 to Q_I^1) and between period t and $t+j$ housing supply falls by $\frac{2(1-(1-\delta)^j)\triangle}{T}$ (Q_0 to Q_I^j). As j goes to infinity and the housing stock fully depreciates, the supply falls by the same amount as it rose due to the positive shock, $\frac{2\triangle}{T}$. At this point, the out-migration of workers also equals the in-migration due to the positive shock.

The asymmetric response of both housing supply and local employment to a positive versus negative shock leads to our first proposition:

Proposition 3 *In the short run, the expansion in housing units and employment in response to a positive labor demand shock will exceed the decline in housing units and employment in response to a negative labor demand shock.*

We also note the following corollary:

Corollary 3.1 *The impact on housing units and employment due to a negative labor demand shock persists beyond the initial period, while the impact due to a positive shock does not.*

The impact on home prices is also asymmetric due to the durability of the housing stock. In our data we observe median home prices and so we focus on the impact on these values here.[37] We first note that the price of a home on the outermost edge of the labor market will be equal to the cost of construction C. At all other distances the price will be equal to the discounted price of the home in the next period plus expected rent minus the expected probability that the home will need to be rebuilt at cost C: $p(d) = \frac{p(d)}{1+\rho} + r(d) - \delta C$, which can be rewritten as $p(d) = \left(\frac{1+\rho}{\rho}\right)(\omega - Td - \delta C)$. Given this, the median home price $\bar{p}$ will be equal to:[38]

$$\bar{p} = \frac{1}{2\rho}\big((1+\rho)\omega + (\rho(1-\delta) - \delta)C\big) \tag{11}$$

[37] We will also observe median rental prices. We assume here that home prices are equivalent to the cumulative discounted flow of rental prices from the property.

[38] This is the price of the home that is halfway between the CBD and the outermost edge of the labor market. This distance is $1/2 \times \left(\frac{\omega_t}{T} - \frac{(\delta+\rho)C}{1+\rho}\right)$, which can be plugged into the equilibrium price equation to obtain the median home price.

It follows that when $\triangle > 0$ the growth in the median home price will be equal to $\left(\frac{1+\rho}{2\rho}\right)\triangle$. When $\triangle < 0$ and the housing stock is durable the decline in the median home price will be equal to $\left(\frac{1+\rho}{2\rho}\right)(2-\delta)\triangle$. Note that when $\delta = 0$ the housing stock is completely durable and the impact on prices due to a negative shock is twice that of a positive shock. At the other extreme, when $\delta = 1$ and the housing stock fully depreciates each period the outcomes are symmetric. The intuition is again depicted in Figure 3: the impact of an *increase* in the local wage ω on home prices is mitigated by the housing supply response (p_0 to p_E in Figure 1), whereas an equivalently-sized *decline* in ω leads home prices to fall more due to the durability of the housing stock (p_0 to p_I). This effect again extends beyond the first period as the negative home price effect is slowly mitigated by the depreciation of the housing stock in future periods.

Proposition 4 *When the housing stock is durable median home prices will fall more in response to a negative labor demand shock than they rise in response to a positive labor demand shock.*[39]

Again we have the related corollary:

Corollary 4.1 *The impact on home prices due to a negative labor demand shock persists beyond the initial period, while the impact due to a positive shock does not.*

Finally, when the cost of building homes (C) varies across markets – for instance, due to differences in land availability – this will lead to heterogeneity in housing supply elasticities at points above the current level of supply (i.e., when $Q^H > Q_0$). Again, we assume the housing supply elasticity below the current level of supply is near zero in all cases in the short run, regardless of building costs. Recall that the boundary of the labor market is given by $\frac{\omega_t}{T} - \frac{(\delta+\rho)C}{1+\rho}$, so the total supply of homes Q^H in the labor market is given by two times this (since homes are built on both sides of the CBD). Solving the equilibrium price condition (11) for ω and plugging it into the equation for Q^H we can calculate the housing supply elasticity associated with the median home:

$$\varepsilon^{HS} \equiv \frac{\%\triangle Q_t^H}{\%\triangle P_t^H} = \frac{\omega - \alpha_1 C}{\omega - \alpha_2 TC} \tag{12}$$

where $\alpha_1 \equiv (\rho(1-\delta) - \delta)$ and $\alpha_2 \equiv \left(\frac{\delta+\rho}{1+\rho}\right)$ are constants. This elasticity is decreasing in C for reasonable values of commuting costs T (they cannot be extremely small),[40] which implies the following result:

[39]In contrast, in the model described in Notowidigdo (2020) the change in rental prices is symmetric in response to positive and negative shocks. This is because housing is homogenous within a labor market – i.e., locational amenities (distance from the CBD) play no role. As a result, rental prices simply rise or fall symmetrically in order to offset the local rise or fall in wages.

[40]The condition for $\frac{d\varepsilon}{dC} < 0$ is that $T > \frac{\rho-\rho\delta-\delta}{\delta+\rho}$. Conservatively allowing for a discount rate of $\rho = 0.1$ and a rapid depreciation of homes of $\delta = 0.05$ we get $\frac{\rho-\rho\delta-\delta}{\delta+\rho} = 0.3$. For context, recall that $r(d) + Td = r(0)$ and assume that the distance from the CBD to the edge of the labor market is 50 miles. For the condition to hold, this implies that the difference in annual rent between those two points must be greater than $50 \times 0.3 = \$15$.

Proposition 5 *The home price response to a positive shock is increasing in the local cost of home building (for reasonable commuting costs T) and, thus, decreasing in the local housing supply elasticity. In contrast, the home price response to a negative shock is invariant to the cost of home building, and the supply elasticity, in the short run.*

We bring the predictions from this theoretical framework to the data using the research design described in the next section.

B Persistence in Outcomes and Treatment

In the model described in Section 2, both positive and negative shocks have contemporaneous effects on outcomes, while negative shocks may also generate effects that persist into future periods (Corollaries 3.1 and 4.1). We refer to this latter channel of impact as "outcome persistence" and specification (1) captures this via the local projection. At the same time, there is a potentially confounding impact on outcomes due to the fact that the shocks themselves may persist into future periods, which we will refer to as "treatment persistence". Typically this channel is not the effect of interest in long-run studies and, in that sense, biases the "true" effect – i.e., the effect due to outcome persistence only. We estimate the importance of the treatment persistence channel in our data in this subsection, finding only a small contribution to the total effect.

To be more specific, Figures 3a and 3b indicate that foreign container port openings generated a discontinuous, one-time rise in the level of U.S. trade flows. However, this one-time shock may have generated an increase in future trade flows as well (a persistence in treatment), perhaps due to increasing efficiency in the use of port infrastructure or due to spillovers from the growing global network of container ports.[41] These intervening treatments in future periods can be thought of as omitted variables in (1), such that the medium- and long-run estimates that we obtain $\{\beta^x_{1990}, \beta^m_{1990}, \beta^x_{2000}, \beta^m_{2000}\}$ reflect the sum of the two effects:

$$\beta^k_{1990} = \underbrace{\theta^k_{1980}}_{\text{Outcome Persistence}} + \underbrace{\gamma^k\theta^k_{1990}}_{\text{Treatment Persistence}} \quad \text{and} \quad \beta^k_{2000} = \underbrace{\theta^k_{1980}}_{\text{Outcome Persistence}} + \underbrace{\gamma^k\theta^k_{2000} + \delta^k\theta^k_{1990}}_{\text{Treatment Persistence}}$$

for $k \in \{X, M\}$ and where θ^k_{1980} in each equation reflects the outcome persistence channel – i.e., it is the direct effect of the initial period container shock on outcomes over the 1980-1990 period and the 1990-2000 periods. The parameters $\{\gamma^k, \delta^k\}$ then reflect the reduced form effects of treatment persistence – i.e., they are the effects of the initial period trade exposure due to the container shock on future trade exposure, conditional on the set of controls in (1).

In fact, we can estimate these parameters in our data. First, γ is the OLS-estimated impact of initial period

[41] This scenario is similar to Cellini et al. (2010) who explore the dynamic effects of the passage of school bonds, where the outcomes depend not only on passage of a particular bond measure but also on the entire history of bond proposals.

(1966-1980) trade exposure on trade exposure in the subsequent period (1980-1990) and is positive for both exports and imports (0.03 and 0.10, respectively, and significant at the one percent level). This indicates that without controlling for medium-run treatment persistence the estimated β's will *overstate* the true impact of the initial shock on outcomes, though we note that the magnitude of this channel is not large.[42] In contrast, we find that δ is negative for exports and imports (-0.004 and -0.02, respectively, and significant at the one percent level) such that without controlling for long-run treatment persistence the estimates will *understate* the true long-run impact of the initial shock, again likely by only a relatively small amount.[43] The estimated coefficients in our medium- and long-run regressions can therefore be thought of as reflecting outcome persistence (the "true" effect) plus a small omitted variable bias due to treatment persistence into future periods.

Note that, in principle, the outcome persistence channel can be fully recovered by conditioning on intervening treatments. However, in practice these controls will be endogenous to the extent that they are correlated with unobservables and so we do not report specifications that include these controls.[44]

C For Online Publication: Variation from Early Port Adopters Only

Table C.1: Trade Exposure Impact on Housing Supply and Employment Growth, 2SLS

	1970-1980	**1970-1990**	**1970-2000**	**1970-1980**	**1970-1990**	**1970-2000**
	(1)	(2)	(3)	(4)	(5)	(6)
	Housing Supply, 2SLS			**Employment, 2SLS**		
Export Exposure	6.893**	7.022	9.241	3.585**	4.613	5.227
	(3.141)	(5.890)	(8.552)	(1.718)	(4.069)	(5.092)
Import Exposure	-2.053	-1.936	-2.885	-1.802**	-3.152	-4.446
	(2.220)	(2.159)	(3.262)	(0.873)	(2.972)	(3.250)
Manufacturing Share	0.003	0.003	0.005	0.003	0.002	0.002
	(0.003)	(0.003)	(0.004)	(0.002)	(0.001)	(0.002)
Pre-Trend in Employment	0.558*	0.418	0.405	0.309	0.300	0.215
	(0.341)	(0.409)	(0.351)	(0.225)	(0.284)	(0.309)
Observations	722	722	722	722	722	722
State FE	✓	✓	✓	✓	✓	✓

Notes: The table reports estimates of the effects from specification (1). The dependent variable is 100 × the change in log number of housing units or log employment in a commuting zone over the period noted. The regressors include 100 × import and export exposure as defined in equations (2) and (3) in the text. We control for pre-trends in the outcome variable and the manufacturing share of employment. Standard errors are clustered at the labor market level. *** Significant at the 1 percent, ** 5 percent, * 10 percent level.

[42] For example, the effect of export treatment persistence on outcomes in 1990 will be $0.03 \times \theta^x_{1990}$.

[43] We note that the medium-run treatment persistence dominates the long-run for both exports and imports ($\delta^k > \gamma^k$), so that β^k_{2000} will slightly overstate the true impact of the initial shock.

[44] We did produce tables of these estimates and the results are not qualitatively different, as expected given the exercise described here. These tables are available upon request.

Table C.2: Trade Exposure Impact on Home Price and Rental Price Growth, 2SLS

	1970-1980	1970-1990	1970-2000	1970-1980	1970-1990	1970-2000
	(1)	(2)	(3)	(4)	(5)	(6)
	Home Prices			**Rental Prices**		
Export Exposure	2.994***	3.545	4.807	2.791**	4.091	4.882
	(1.302)	(2.851)	(4.913)	(1.352)	(3.762)	(4.815)
Import Exposure	-3.292***	-3.580*	-3.881	-4.219***	-4.993**	-5.428
	(1.214)	(2.276)	(3.508)	(2.005)	(2.713)	(5.558)
Manufacturing Share	0.002	0.001*	0.001	0.003	0.002	0.003
	(0.002)	(0.000)	(0.000)	(0.003)	(0.003)	(0.003)
Pre-Trend in Home Prices	0.481	0.336	0.218	0.557	0.601*	0.482
	(0.453)	(0.381)	(0.311)	(0.436)	(0.380)	(0.451)
Observations	722	722	722	722	722	722
State FE	✓	✓	✓	✓	✓	✓

Notes: The table reports estimates of the effects from specification (1). The dependent variable is 100 × the change in log median home price in a commuting zone over the period noted. Values are in 2012 $. The regressors include 100 × import and export exposure as defined in equations (2) and (3) in the text. We control for pre-trends in the outcome variable and the manufacturing share of employment. Standard errors are clustered at the labor market level. *** Significant at the 1 percent, ** 5 percent, * 10 percent level.

D Estimates from Lasso-Based IVs

Table D.3: Trade Exposure Impact on Housing Supply and Employment Growth, 2SLS

	1970-1980	1970-1990	1970-2000	1970-1980	1970-1990	1970-2000
	(1)	(2)	(3)	(4)	(5)	(6)
	Housing Supply			**Employment**		
Export Exposure	8.205***	9.243*	9.337	5.328**	6.214	6.711
	(2.697)	(5.913)	(7.470)	(3.141)	(5.126)	(5.392)
Import Exposure	-3.277	-4.192	-4.504	-2.908**	-4.018	-4.648
	(4.138)	(4.509)	(5.331)	(1.381)	(3.761)	(4.809)
Manufacturing Share	0.002	0.003	0.002	0.003	0.002	0.002
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)
Pre-Trend in Employment	0.448*	0.325	0.318*	0.562	0.493	0.374
	(0.294)	(0.307)	(0.339)	(0.183)	(0.524)	(0.416)
Observations	722	722	722	722	722	722
State FE	✓	✓	✓	✓	✓	✓

Notes: The table reports estimates of the effects from specification (1). The dependent variable is 100 × the change in log employment in a commuting zone over the period noted. The regressors include 100 × import and export exposure as defined in equations (2) and (3) in the text. We control for pre-trends in the outcome variable and the manufacturing share of employment. Standard errors are clustered at the labor market level. *** Significant at the 1 percent, ** 5 percent, * 10 percent level.

Table D.4: Trade Exposure Impact on Home Price and Rental Price Growth, 2SLS

	1970-1980	1970-1990	1970-2000	1970-1980	1970-1990	1970-2000
	(1)	(2)	(3)	(4)	(5)	(6)
	Home Prices, 2SLS			**Rental Prices, 2SLS**		
Export Exposure	5.349***	7.293	8.444	4.582***	6.091	6.992
	(2.201)	(6.982)	(9.419)	(2.242)	(5.447)	(7.514)
Import Exposure	-7.352***	-8.114**	-8.230	-4.914***	-7.254***	-7.833
	(0.679)	(2.535)	(4.095)	(1.639)	(8.144)	(10.413)
Manufacturing Share	0.003	0.002*	0.000**	0.002	0.002	0.001
	(0.002)	(0.001)	(0.000)	(0.003)	(0.003)	(0.003)
Pre-Trend in Home Prices	0.522	0.419	0.400	0.691	0.406*	0.381*
	(0.442)	(0.491)	(0.504)	(0.551)	(0.293)	(0.185)
Observations	722	722	722	722	722	722
State FE	✓	✓	✓	✓	✓	✓

Notes: The table reports estimates of the effects from specification (1). The dependent variable is 100 × the change in log median home price in a commuting zone over the period noted. Values are in 2012 $. The regressors include 100 × import and export exposure as defined in equations (2) and (3) in the text. We control for pre-trends in the outcome variable and the manufacturing share of employment. Standard errors are clustered at the labor market level. *** Significant at the 1 percent, ** 5 percent, * 10 percent level.