SUPPLEMENT TO: "TRADE AND LABOR MARKET DYNAMICS: GENERAL EQUILIBRIUM ANALYSIS OF THE CHINA TRADE SHOCK"

LORENZO CALIENDO[a], MAXIMILIANO DVORKIN[b] AND FERNANDO PARRO[c]

EXAMPLES OF COUNTERFACTUALS USING DYNAMIC HAT ALGEBRA

In this appendix, we discuss what type of questions can be answered using the dynamic hat algebra methodology and what measurements are required to do so. Overall, the results from Propositions 2 and 3 can be applied to study different types of counterfactuals: They can be used to i) simulate an economy that is not in steady state in a given year and where agents expect no further changes in fundamentals going forward; ii) simulate an economy that is not in steady state in a given year and where agents anticipate the actual changes in fundamentals going forward; iii) compute the changes in allocations in an economy where agents anticipate the actual changes in fundamentals but instead a subset of fundamentals change in a different way from the true changes; iv) compute the changes in allocations in an economy where agents do not expect changes in fundamentals but a subset of fundamentals surprisingly increase (or fall) in a given period; v) compute the changes in allocations in an economy where agents do not anticipate the actual changes in a subset of fundamentals in a given period; and vi) compute the changes in allocations in an economy where agents anticipated the actual changes in fundamentals but the changes in a subset of fundamentals did not happen. The last example is the type of counterfactual we study in the empirical part of the paper to evaluate the effects of the China shock. In what follows, we describe how to compute the equilibrium changes in allocations in each of the first five types of counterfactuals and their measurement requirements.

To do so, we study different examples of the types of counterfactuals described above. In Example 1, we study dynamics with constant fundamentals. Concretely we answer the question: how would the U.S. economy have evolved over time, and what would its long-run features have been, given the fundamentals in the initial period? We also answer the question: how would the U.S. economy have evolved over time, and what would its long-run features have been, if agents had anticipated the actual changes in fundamentals over the period 2000-2007? In Example 2, we show how to study the effects of unexpected changes in fundamentals relative to constant fundamentals. In particular, we answer the following question: what would have happened across U.S. labor markets if Chinese fundamental productivity, instead of growing as it did, had grown 20% less in each manufacturing sector per year from 2000 to 2007? In Example 3, we show how to study the effects of unexpected changes in fundamentals relative to actual changes in fundamentals.

[a]lorenzo.caliendo@yale.edu.
[b]maximiliano.a.dvorkin@stls.frb.org.
[c]fparro1@jhu.edu.

In particular we study the question: what would have happened to the U.S. economy if Chinese fundamental productivity in each manufacturing sector surprisingly grew 20% but agents expected no changes? Finally, in Example 4 we study the effects of actual changes in fundamentals. Concretely, we answer the question: what would have happened if agents expected constant fundamentals and unexpectedly Chinese productivity grew as it did?

For all of the examples presented in this appendix, we use the data described in Section 4 of the paper. Also, as in the paper, we use a version of the model with 50 U.S. states, 37 other countries, including China, and a constructed rest of the world. For further details, see Section 4 in the main text of the paper.

EXAMPLE 1. DYNAMICS WITH CONSTANT FUNDAMENTALS

1.1. *The evolution of the U.S. economy with constant year 2000 fundamentals*

We start by describing the evolution of the U.S. economy with constant fundamentals. In particular, in this section we answer the question: how would the economy have evolved over time and what would its long-run features have been given the fundamentals in the initial period? To do so, we simulate the economy with constant fundamentals using the results from Proposition 2. In order to take the model to the data, we need to input the set of constant parameters given by the value added shares (γ^{nj}), the labor shares in value added (1-ξ^n), the input-output coefficients ($\gamma^{nk,nj}$), the portfolio shares (ι^n), the final consumption expenditure shares (α^j), the trade elasticities (θ), the discount factor (β), and the migration elasticity (ν). This set of parameters is needed for all the examples that we present in this appendix. In addition, since we are computing a world with constant fundamentals, we need the cross-sectional data on employment, trade flows, expenditures, and migration flows for the year 2000, namely $(L_0, \pi_0, X_0, \mu_{-1})$. In what follows, we describe the changes in allocations in the U.S. economy predicted by our model.

As discussed in the main text, one implication of Proposition 2 is that in steady state the value functions in time differences must converge to zero, or $\dot{u}^{nj}_{SS} = 1$ for all labor markets. To illustrate this point, Figure 1 shows the evolution of the time difference in the value functions for the U.S. economy starting in the year 2000.

We now describe the changes in allocations in the simulated model with constant fundamentals. Starting with sectoral employment, the upper-left panel in Figure 2 presents the dynamic responses of the manufacturing employment share. We find that in the absence of changes in fundamentals from the year 2000 and thereafter, the manufacturing employment share falls by about 1.25 percentage points, from about 16.5% in the year 2000 to about 15.3% in steady state. As shown in the other three panels of Figure 2, the employment share of the wholesale and retail industry declines by a bit more than 0.1 percentage point. On the other hand, workers relocate mainly to services, which experiences

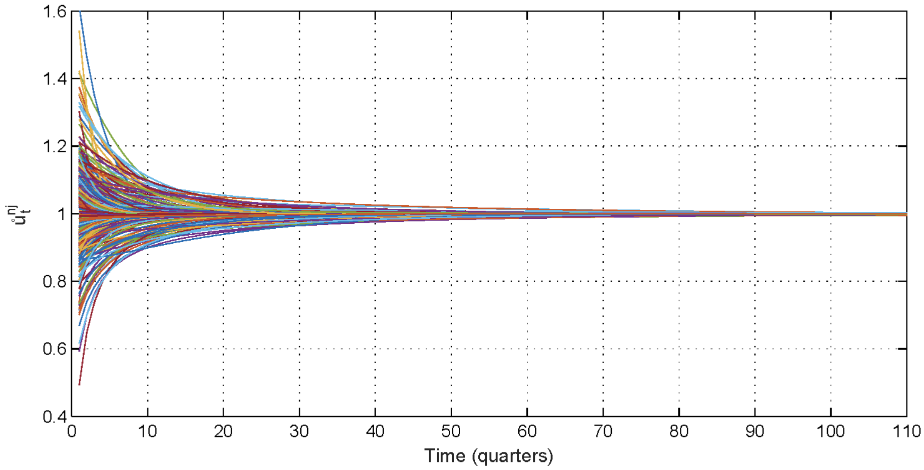

Figure 1: Value functions with constant fundamentals

Note: The figure presents the evolution of the value functions in time differences for each labor market.

an increase in its employment share of about 1.22 percentage points, and the employment share in construction slightly increases in steady state. It is worth emphasizing that the model generates transitional dynamics toward a steady-state equilibrium even in the absence of any changes in fundamentals and that these dynamics occur because the economy is not in a steady state in the year 2000. In other words, the observed employment in manufacturing in 2000 is the equilibrium result of past changes in fundamentals and, as a result, the economy is transitioning to a new steady state.

We proceed to further explore the decline in manufacturing employment given the year 2000 fundamentals. In particular, we quantify the relative contribution of different sectors and regions to the decline in the manufacturing share of employment.

Figure 3 shows the contribution of each manufacturing industry to the total decline in manufacturing employment. The largest contributors to the decline in manufacturing employment are the computer and electronics and wood and paper industries, followed by the machinery and textiles industries. On the other hand, the furniture and petroleum industries experience an increase in employment. As discussed above, movements in employment across different industries reflect the fact that the economy is not in steady state in the year 2000 and that the data in the year 2000 contains information on past changes to fundamentals.

Figure 4 presents the contribution of each region to the total decline in manufacturing employment with constant fundamentals. The state that contributes the most is New York, accounting for about 13% of the total decline, followed by Ohio and Pennsylvania. In the absence of changes to fundamentals, several states such as Arizona, Kentucky, and Nevada, among others, experience an increase in manufacturing employment.

While Figure 4 shows the spatial distribution of the aggregate decline in manufacturing

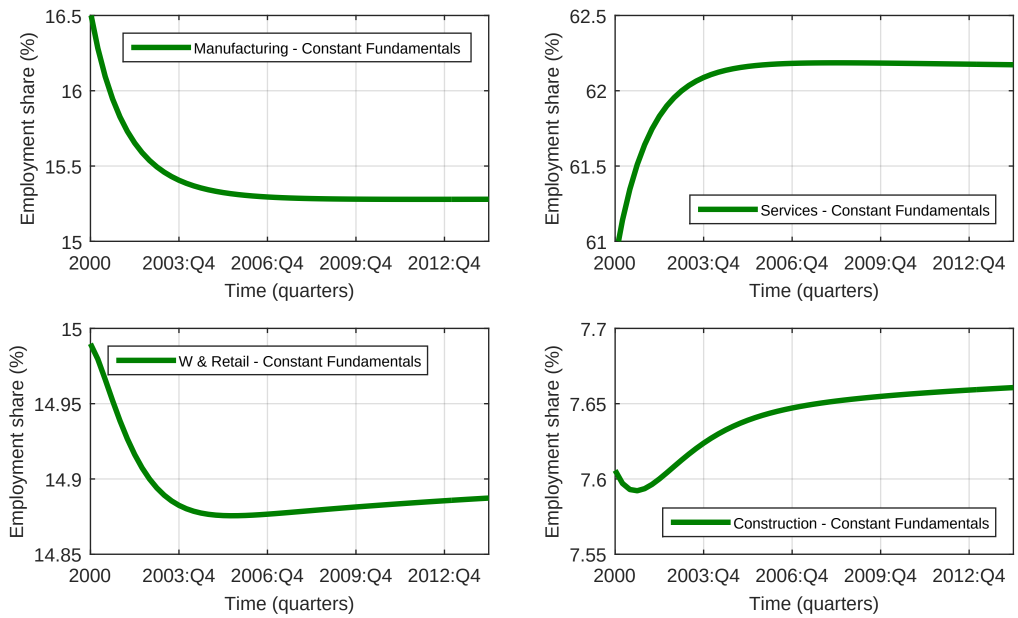

Figure 2: The evolution of employment shares with constant year 2000 fundamentals (Example 1)

Note: The figure presents the evolution of employment in each sector (manufacturing, services, wholesale and retail, and construction) over total employment. Total employment excludes farming, utilities, and the public sector. The employment shares are computed from the model with constant year 2000 fundamentals.

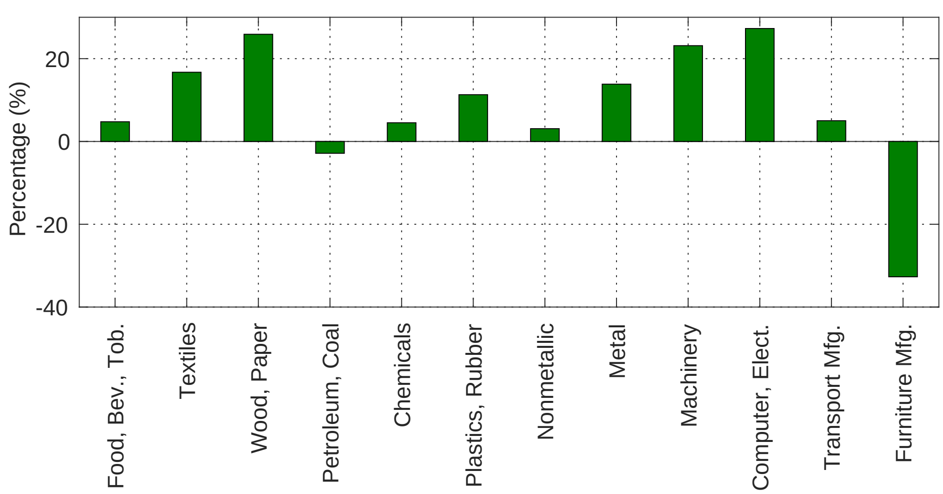

Figure 3: Manufacturing employment declines (percent of total)

Note: The figure presents the contribution of each manufacturing industry to the total reduction in manufacturing employment. The results are computed from the model with constant year 2000 fundamentals.

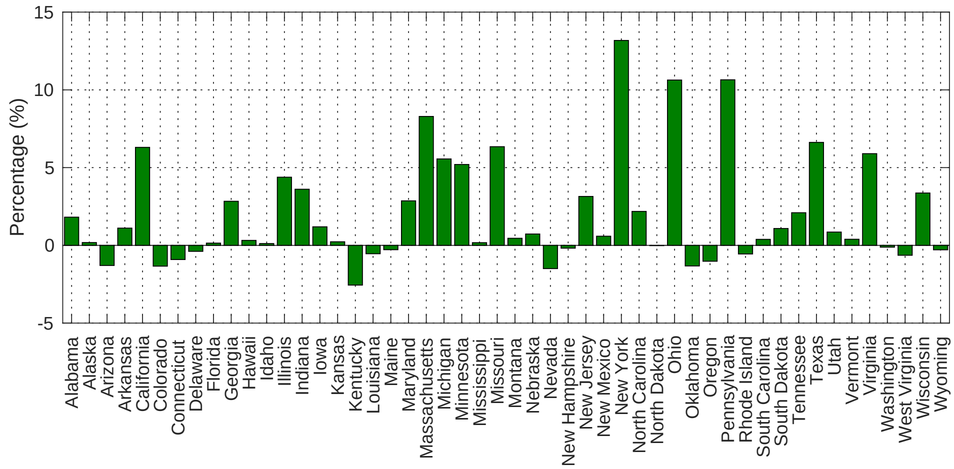

Figure 4: Regional contributions to the aggregate U.S. manufacturing employment decline (percent)

Note: The figure presents the contribution of each state to the total reduction of employment in the manufacturing sector. The results are computed from the model with constant 2000 fundamentals.

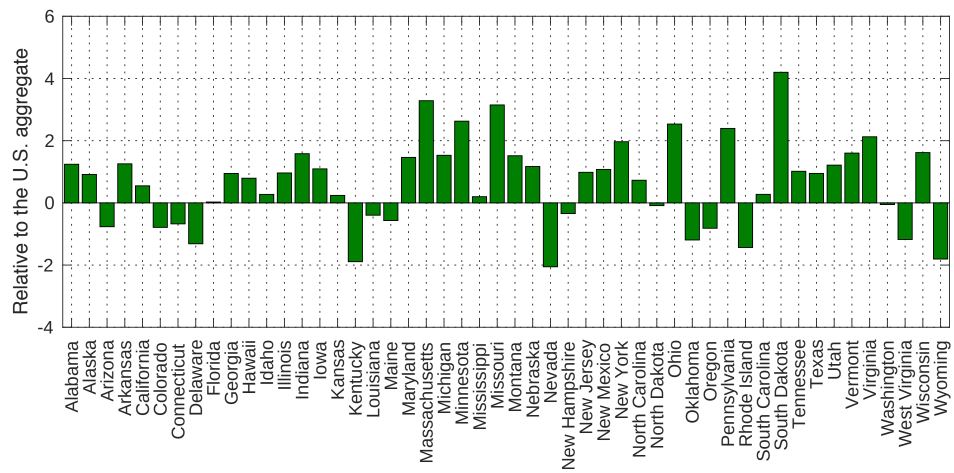

Figure 5: Regional contribution to aggregate U.S. manufacturing employment decline normalized by regional employment share

Note: The figure presents the contribution of each state to the aggregate U.S. reduction in manufacturing employment normalized by the employment in each state relative to aggregate U.S. employment. The results are computed from the model with constant year 2000 fundamentals.

employment, it is also informative to study the local employment change in each region with constant fundamentals. For instance, even when New York contributes the most to the U.S. manufacturing employment decline, part of it could be because it concentrates a large fraction of U.S. manufacturing employment. However, as discussed in the main text, larger regions also tend to be more diversified; that is, employment and production are also important in other sectors, such as services. Therefore, although the contribution of these regions to the aggregate decline in manufacturing employment is large, the local impact could be mitigated compared with smaller, less-diversified regions where manufacturing represents a higher share of local employment. This local impact is shown in Figure 5, which displays the state contribution to the total decline in manufacturing employment normalized by the employment share of each state relative to aggregate U.S. employment. As we can see from this figure, the local impact on manufacturing employment in larger, more-diversified states, such as New York and Pennsylvania, is smaller than on less-diversified states, such as South Dakota or Missouri.

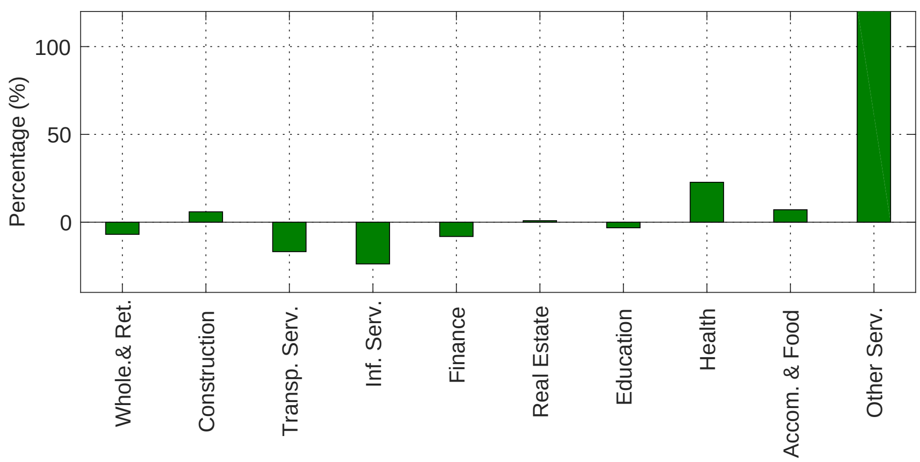

Figure 6: Non-manufacturing employment increases (percent of total)

Note: The figure presents the contribution of each non-manufacturing sector to the total increase in the non-manufacturing employment. The results are computed from the model with constant year 2000 fundamentals.

We now describe the sectoral and spatial distributions of the employment gains in the non-manufacturing industries with constant fundamentals. The sectoral contribution to the change in non-manufacturing employment is displayed in Figure 6. We find that with constant fundamentals, employment relocates to only a few sectors, namely construction, real estate, health, accommodation and food, and other services. The rest of the non-manufacturing sectors experience a decline in their employment shares. As discussed above, the changes in employment shares in non-manufacturing industries result from the fact that the economy was not in steady state in the year 2000. Figure 7 shows that across regions, Florida explains most of the increase in non-manufacturing employment. Notably, the figure suggests that if fundamentals would have stayed constant in the U.S. economy at the year 2000 level, New York would have experienced a large decline in employment in the services industry and households would have relocated to other states as a result.

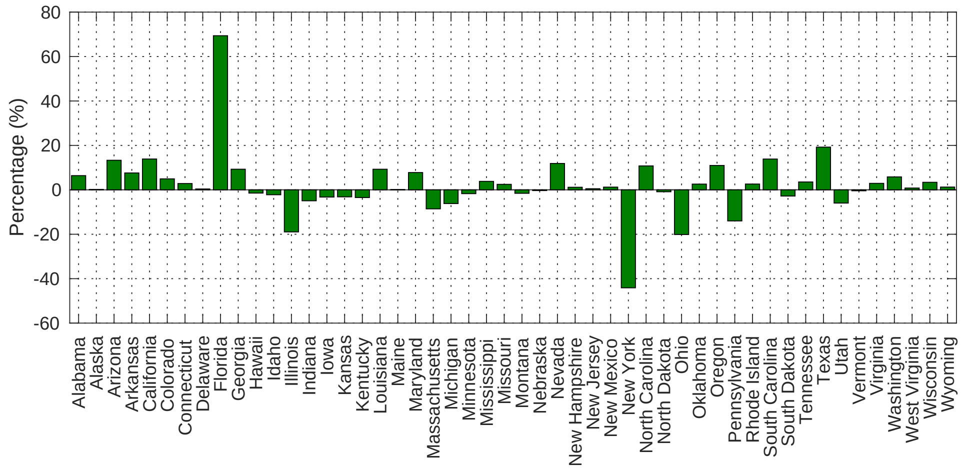

Figure 7: Regional contributions to the aggregate U.S. non-manufacturing employment increase (percent)

Note: The figure presents the contribution of each state to the total rise in non-manufacturing employment. The results are computed from the model with constant year 2000 fundamentals.

1.2. *The evolution of the U.S. economy with 2000-2007 actual time-varying fundamentals*

We now describe the evolution of the U.S. economy with time varying fundamentals from 2000 to 2007 and constant fundamentals from 2007 and thereafter. In particular, in this section we answer the question: how would the economy have evolved over time, and what would its long-run features have been if agents anticipated the actual changes in fundamentals over the period 2000-2007?

To do so, we take the model to the data using time-series data on employment, migration flows, trade flows, and expenditures over the period 2000-2007, namely $\{L_t, \mu_{t-1}, \pi_t, X_t\}_{t=2000}^{2007}$. We then simulate the economy with constant fundamentals after 2007 using the results from Proposition 2. In what follows, we describe the change in allocations predicted by our model with time-varying fundamentals. As discussed in the main text, we do not need to know the level or the actual evolution of the fundamentals from 2000 to 2007 to compute this counterfactual example.

Starting with sectoral employment, the upper-left panel in Figure 8 presents the dynamic responses of the manufacturing share of employment. We find that the manufacturing employment share declines from 16.5% in 2000 to about 13.7% in steady state or by about 2.8 percentage points. Therefore, we find a larger fall in the manufacturing employment share compared to the simulated economy with constant fundamentals.

The larger manufacturing employment decline with time-varying fundamentals suggests that the past changes in fundamentals, as well as the actual changes in fundamentals over the period 2000-2007 resulted in a steady fall in manufacturing employment. In this context, constant fundamentals slow this falling path, which explains why the steady state manufacturing employment share is larger with constant fundamentals. As shown in the other three panels of Figure 8, the larger fall in manufacturing employment with time-varying fundamentals results in a larger relocation of workers to construction and services compared with an economy with constant fundamentals.

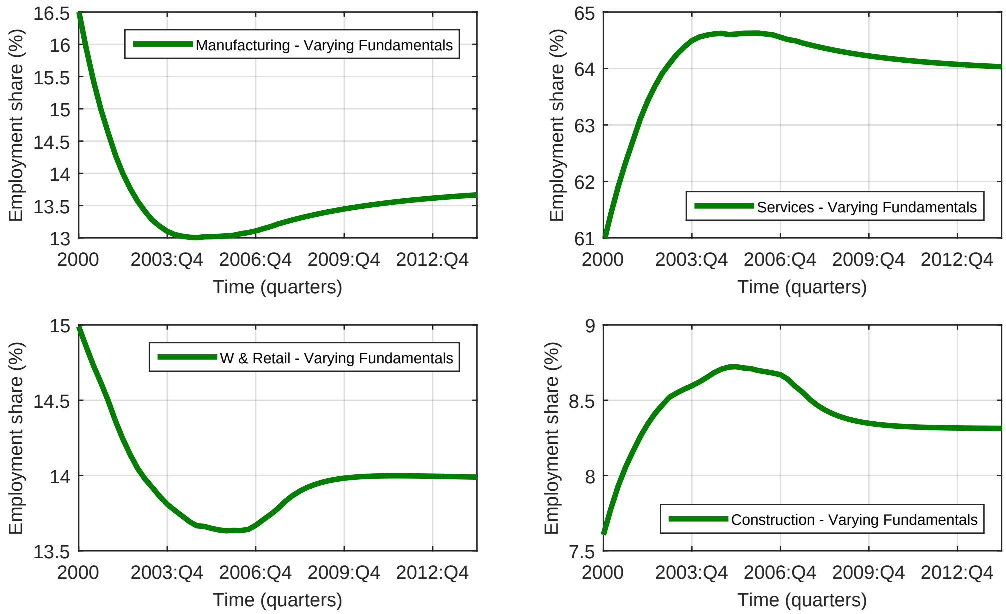

Figure 8: The evolution of employment shares with time varying 2000-2007 fundamentals (Example 1)

Note: The figure presents the evolution of employment in each sector (manufacturing, services, wholesale and retail, and construction) over total employment. Total employment excludes farming, utilities, and the public sector. The employment shares are computed from the model with the actual change in fundamentals over 2000-2007.

Turning to the sectoral contributions to the decline in manufacturing employment shares, Figure 9 shows that the largest contributors are the computers and electronics, wood and paper, and textiles industries. On the other hand, the food, beverage and tobacco; petroleum; and nonmetallic industries experience an increase in their employment shares with time-varying fundamentals.

Across regions, Figure 10 shows that with time varying fundamentals, the states that contribute the most to the decline in manufacturing employment are Alabama, California, Illinois, and Pennsylvania. It is worth mentioning that the relative contributions of different states are different from the one in an economy with constant fundamentals, suggesting heterogeneity in the actual change to fundamentals across space over 2000-2007.

When normalizing by the regional employment shares in Figure 11, and analogous

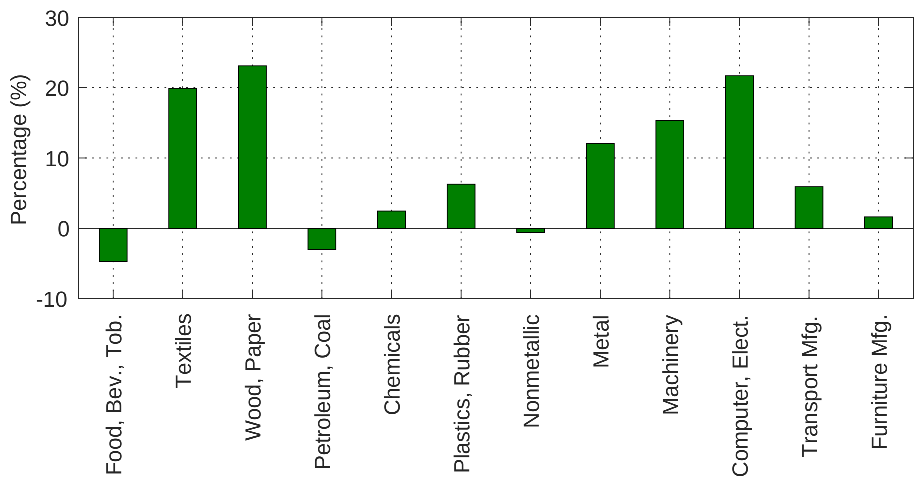

Figure 9: Manufacturing employment declines (percent of total)

Note: The figure presents the contribution of each manufacturing industry to the total decline in manufacturing employment. The results are computed from the model with the actual changes in fundamentals over 2000-2007.

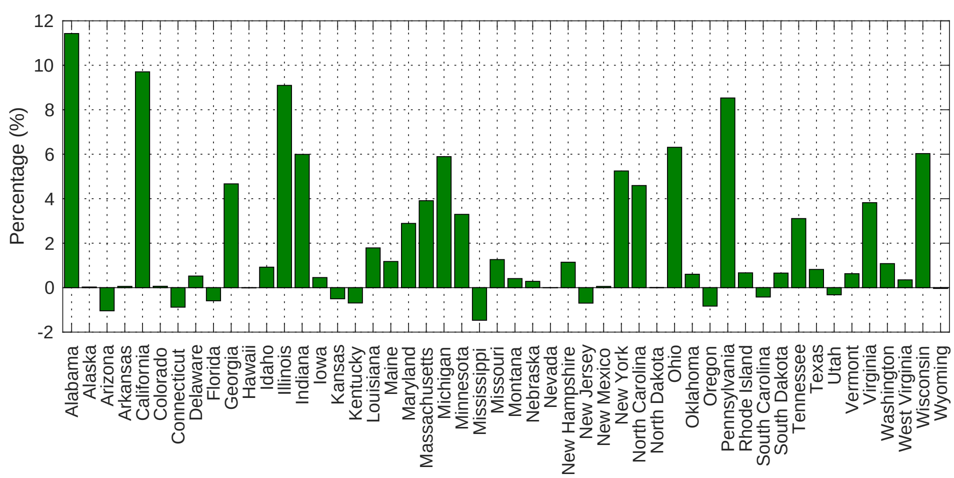

Figure 10: Regional contribution to aggregate U.S. manufacturing employment decline (percent)

Note: The figure presents the contribution of each state to the total decline in manufacturing employment. The results are computed from the model with the actual changes in fundamentals over 2000-2007.

to the case with constant fundamentals, we find that the local impact on larger, more-diversified regions is smaller relative to smaller, less-diversified states, such as Alabama.

We now describe the sectoral and spatial distributions of the employment gains in the non-manufacturing industries with time-varying fundamentals. The sectoral contributions to the change in non-manufacturing employment is displayed in Figure 12. Similar to the case with constant fundamentals, we find that the increase in non-manufacturing

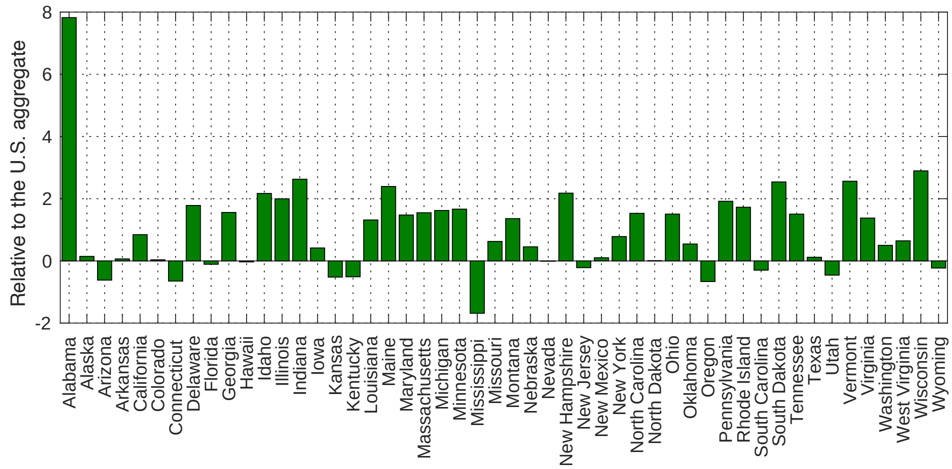

Figure 11: Regional contribution to aggregate U.S. manufacturing employment decline normalized by regional employment share

Note: The figure presents the contribution of each state to the aggregate U.S. decline in manufacturing employment normalized by the employment of each state relative to the aggregate U.S. employment. The results are computed from the model with the actual changes in fundamentals over 2000-2007.

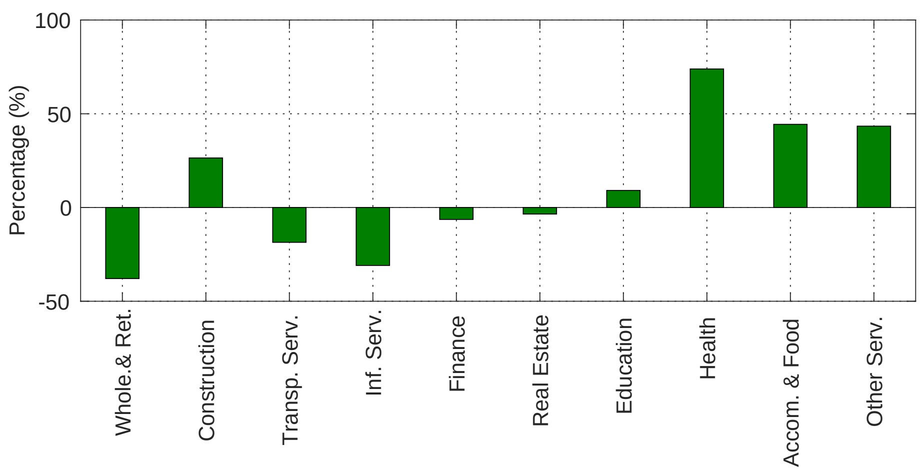

Figure 12: Non-manufacturing employment increases (percent of total)

Note: The figure presents the contribution of each non-manufacturing sector to the total increase in non-manufacturing employment. The results are computed from the model with the actual changes in fundamentals over 2000-2007.

employment is localized in a few industries: construction, education, health, accommodation and food, and other services. However, the relative contribution of each industry with time-varying fundamentals is also different from the case with constant fundamentals, pointing to the heterogeneity of the changes in fundamentals across industries.

The same conclusion emerges when looking at the regional contribution to the increase

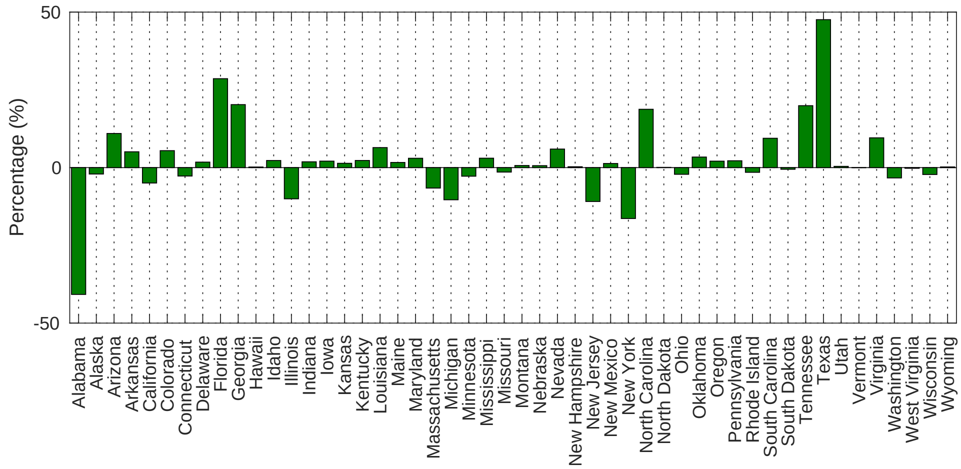

Figure 13: Regional contributions to the aggregate U.S. non-manufacturing employment increase (percent)

Note: The figure presents the contribution of each state to the total rise in non-manufacturing employment. The results are computed from the model with the actual changes in fundamentals over 2000-2007.

in non-manufacturing employment with time-varying fundamentals showed in Figure 13. The relative changes in non-manufacturing employment are also different compared with the economy with constant fundamentals highlighting the effects of time-varying fundamentals. Overall, we find that the region that contributes the most to the increase in employment in non-manufacturing industries is Texas, followed by Florida.

EXAMPLE 2. UNEXPECTED CHANGES IN FUNDAMENTALS RELATIVE TO CONSTANT FUNDAMENTALS

2.1. *With constant fundamentals, what if Chinese fundamental productivity unexpectedly grew 20% per year between 2000 and 2007?*

We now apply the results from Proposition 3 to answer the following question: what would have happened to the U.S. economy if Chinese fundamental productivity, A_t^{ij}, in each manufacturing industry surprisingly grew 20% but agents expected no changes? The results from Proposition 3 show that, in order to conduct this counterfactual, we need first to compute the baseline economy with constant fundamentals, as we did in Example 1. Similar to the previous example, we do not need to measure the shock since this is a hypothetical 20% increase in fundamental productivity.

As in the previous example, we start by describing the evolution of the employment shares. Figure 14 shows the dynamics of employment shares. The solid lines show the evolution of employment shares in the baseline economy with constant fundamentals described in Example 1, and the dashed lines show the evolution of employment shares in the counterfactual economy with 20% productivity growth in China.

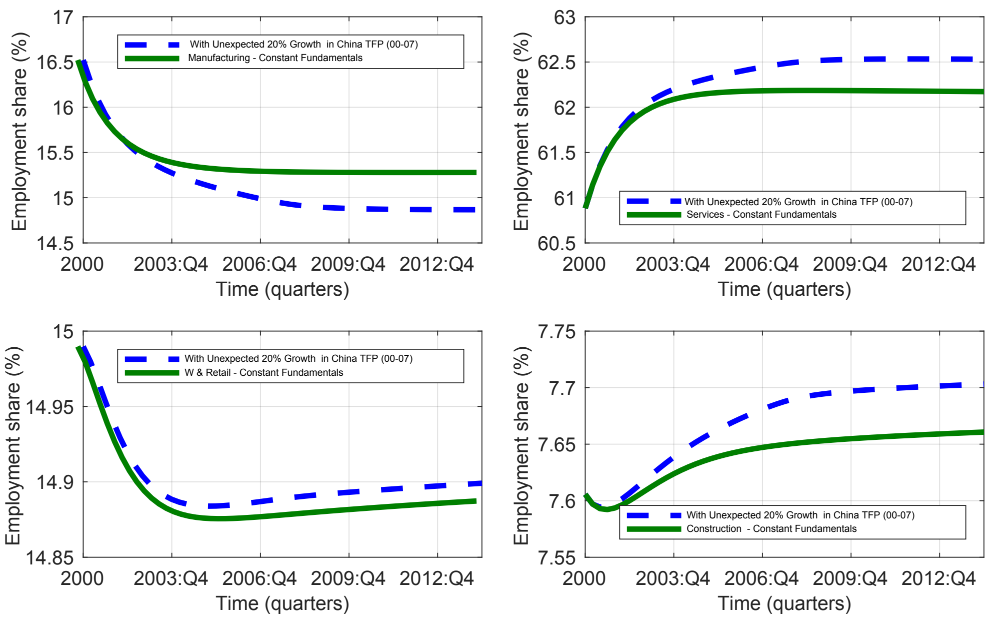

Figure 14: The evolution of employment shares (Example 2)

Note: The figure presents the evolution of employment in each sector (manufacturing, services, wholesale and retail, and construction) over total employment. Total employment excludes farming, utilities, and the public sector. The dashed lines represent the shares computed from a counterfactual with constant fundamentals and an unexpected 20% fundamental TFP increase in all sectors in China per year from 2000-2007. The solid lines represent the shares from the economy with constant 2000 fundamentals.

As before, the difference between both lines, displayed in Figure 15, shows the effects of a 20% productivity growth in China on U.S. employment shares. We find that manufacturing employment declines by about 0.42 percentage points in steady state. As shown in the other three panels, workers relocate mainly to services industries for which the employment share increases by 0.35 percentage points, while the employment shares for the construction and wholesale and retail industries are slightly higher.

In Figure 16, we present the relative contribution of each manufacturing industry to the total decline in manufacturing employment due to the productivity growth in China. We find that the computer and electronics industry accounts for about 43% of the total decline, followed by the metals, furniture, and textile industries, which together account for about 45% of the decline.

Figure 17 shows the regional contributions to the decline in U.S. manufacturing employment due to the productivity growth in China. We find that California is the largest contributor and accounts for about 13% of the total decline, followed by Texas which accounts for about 7%.

In Figure 18, we study the local impact of the productivity growth in Chinese manufacturing industries by normalizing the regional contributions by the regional employment

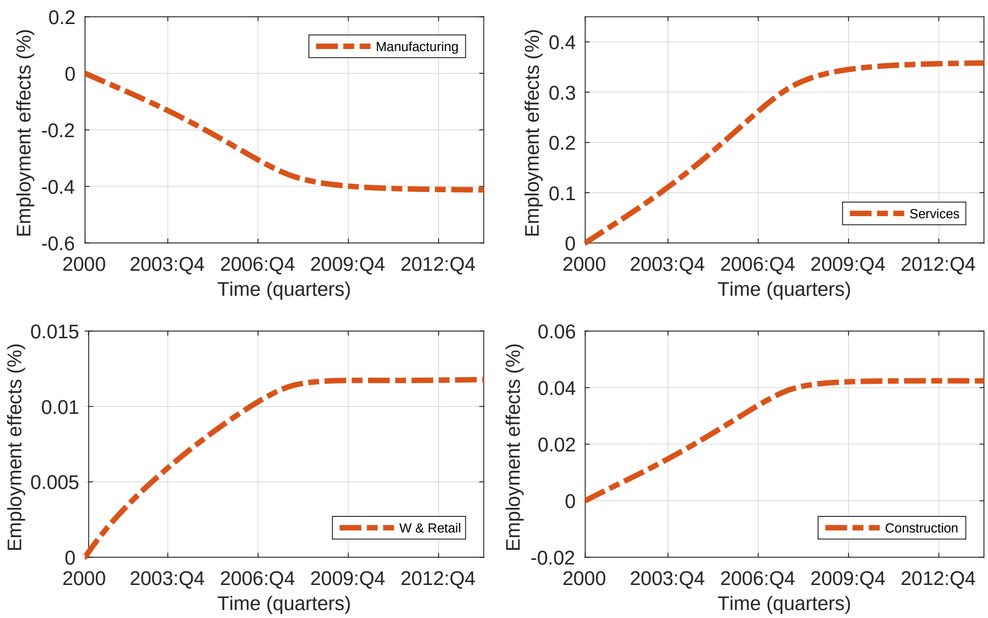

Figure 15: Counterfactual effects on employment shares (Example 2)

Note: The figure presents the effects, measured as the change in employment shares by sector (manufacturing, services, wholesale and retail, and construction) over total employment, from a counterfactual with all fundamentals constant except for 20% annual growth in China's fundamental TFP over the period 2000-2007.

shares. We find that the local impact on larger, more-diversified states, such as California and Texas, is smaller relative to other smaller, less-diversified states such as North Carolina, South Carolina, Rhode Island, and New Hampshire.

Turning to the results for non-manufacturing industries, in Figure 19 we present the contributions of different industries to the increase in U.S. employment in non-manufacturing industries. We find that besides the other services industry, the health industry is the largest contributor among non-manufacturing industries, accounting for about 22% of the total increase in the non-manufacturing employment share, followed by the education and construction industries, which together account for about 22% of the decline. Overall, we find that all non-manufacturing industries absorbed workers displaced from manufacturing industries.

Figure 20 presents the contributions across states to the total non-manufacturing employment increase. Similar to the previous example, states with larger services sectors such as California and New York, contribute more to the total change in non-manufacturing employment. In particular, the largest contributor is New York, which accounts for about 13% of the total increase followed by California.

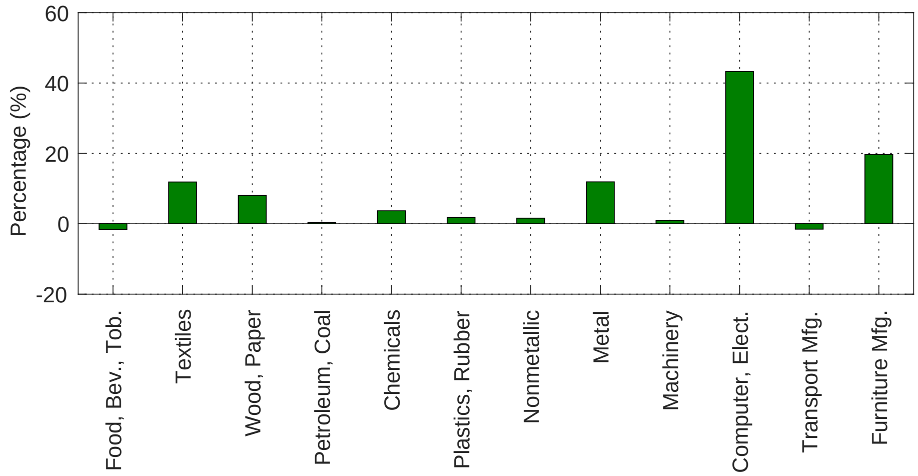

Figure 16: Manufacturing employment declines (percent of total)

Note: The figure presents the contribution of each manufacturing industry to the total decline in manufacturing employment. The results presented are the effects of an unexpected 20% fundamental TFP increase in all manufacturing sectors in China per year from 2000-2007 relative to a baseline with constant 2000 fundamentals.

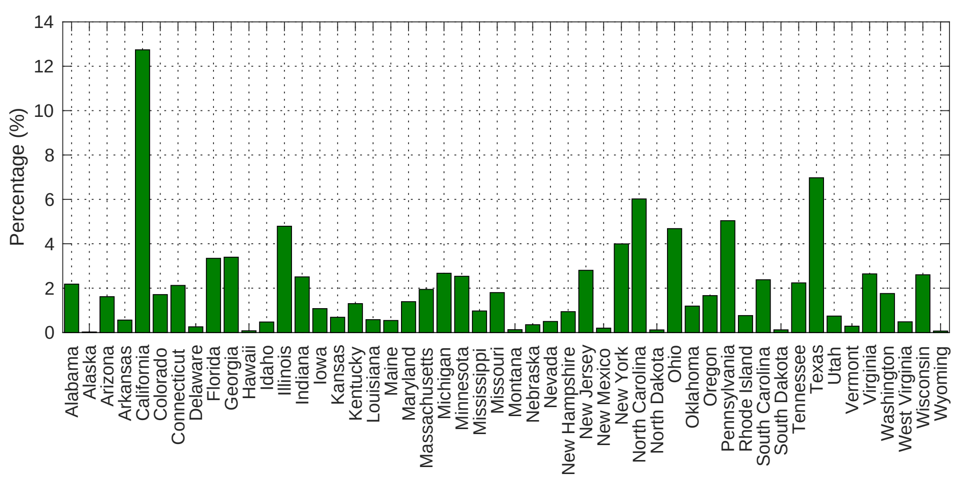

Figure 17: Regional contributions to the aggregate U.S. manufacturing employment decline (percent)

Note: The figure presents the contribution of each state to the total decline in manufacturing. The results presented are the effects of an unexpected 20% fundamental TFP increase in all manufacturing sectors in China per year from 2000-2007 relative to a baseline with constant 2000 fundamentals.

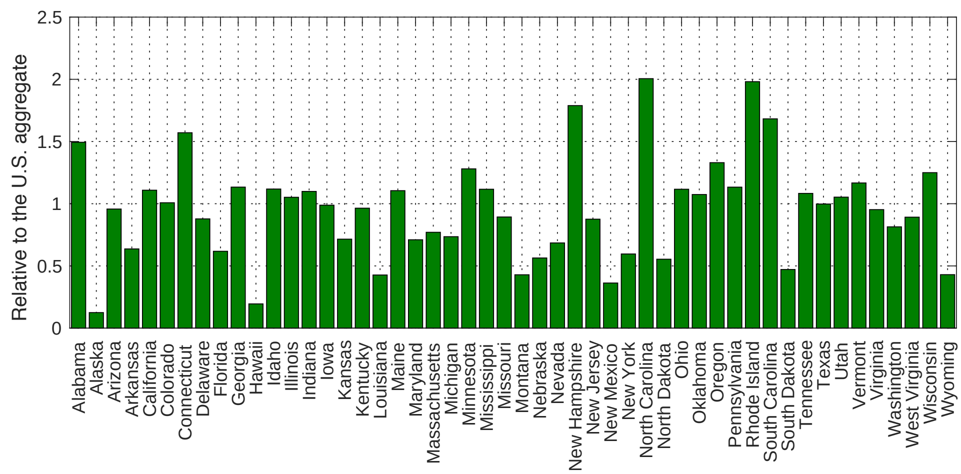

Figure 18: Regional contribution to aggregate U.S. manufacturing decline normalized by regional employment share

Note: The figure presents the contribution of each state to the aggregate U.S. decline in manufacturing employment normalized by the employment of each state relative to aggregate U.S. employment. The results presented are the effects of an unexpected 20% fundamental TFP increase in all manufacturing sectors in China per year from 2000-2007 relative to a baseline with constant 2000 fundamentals.

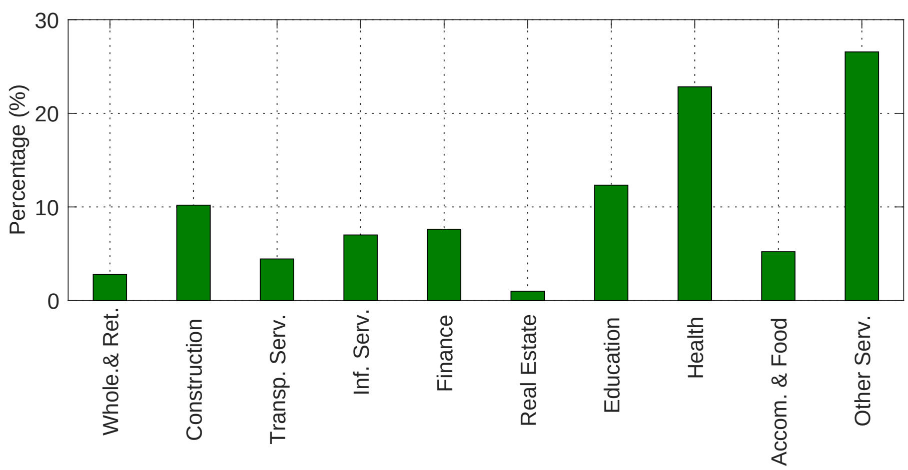

Figure 19: Non-manufacturing employment increases (percent of total)

Note: The figure presents the contribution of each non-manufacturing sector to the total increase in non-manufacturing employment. The results presented are the effects of an unexpected 20% fundamental TFP increase in all manufacturing sectors in China per year from 2000-2007 relative to a baseline with constant 2000 fundamentals.

EXAMPLE 3. UNEXPECTED CHANGES IN FUNDAMENTALS RELATIVE TO ACTUAL FUNDAMENTALS

3.1. *What if Chinese fundamental productivity had grown 20% less in each manufacturing sector?*

We now apply the results from Proposition 3 to answer a different counterfactual question: what would have happened across U.S. labor markets if Chinese fundamental

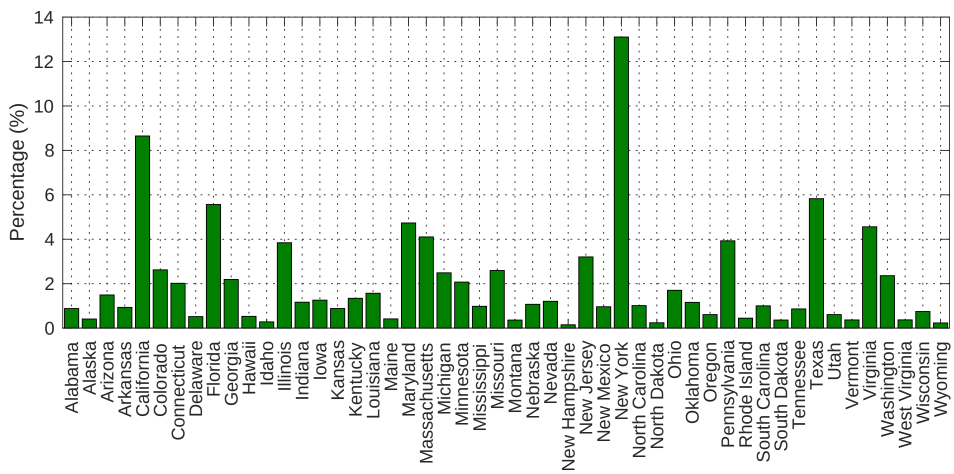

Figure 20: Regional contributions to the aggregate U.S. non-manufacturing employment increase (percent)

Note: The figure presents the contribution of each state to the total increase in non-manufacturing employment. The results presented are the effects of an unexpected 20% fundamental TFP increase in all manufacturing sectors in China per year from 2000-2007 relative to a baseline with constant 2000 fundamentals.

productivity, A_t^{ij}, instead of growing as it did, had grown 20% less in each manufacturing sector per year from 2000 to 2007? The results from Proposition 3 show that in order to conduct this counterfactual, we need data on the factual baseline economy, but we do not need to measure the shock since this is a hypothetical 20% reduction in fundamental productivity relative to the actual one.

As before, we start by describing the evolution of the employment shares. Figure 21 shows the dynamics of the employment shares in the manufacturing, services, wholesale and retail, and construction industries. The solid lines show the evolution of employment shares in the factual baseline economy described in Example 1, that is, the actual changes in fundamentals over 2000-2007. The dashed line shows the evolution of employment shares in the counterfactual economy with 20% less productivity growth in China.

The difference between both lines, displayed in Figure 22, shows the effect on employment shares of a 20% less productivity growth in China. Starting with the first panel, we find that manufacturing employment increases by about 0.27 percentage points in steady state as a consequence of reduced import competition from China. The other three panels show that workers relocate mainly from the services industries, for which the employment share declines by 0.22 percentage points. Employment shares in the construction and wholesale and retail industries are slightly lower with the lower.

In Figure 23, we present the relative contribution of each manufacturing industry to the total increase in manufacturing employment with 20% less productivity growth in China. We find that the computer and electronics industry is the largest contributor,

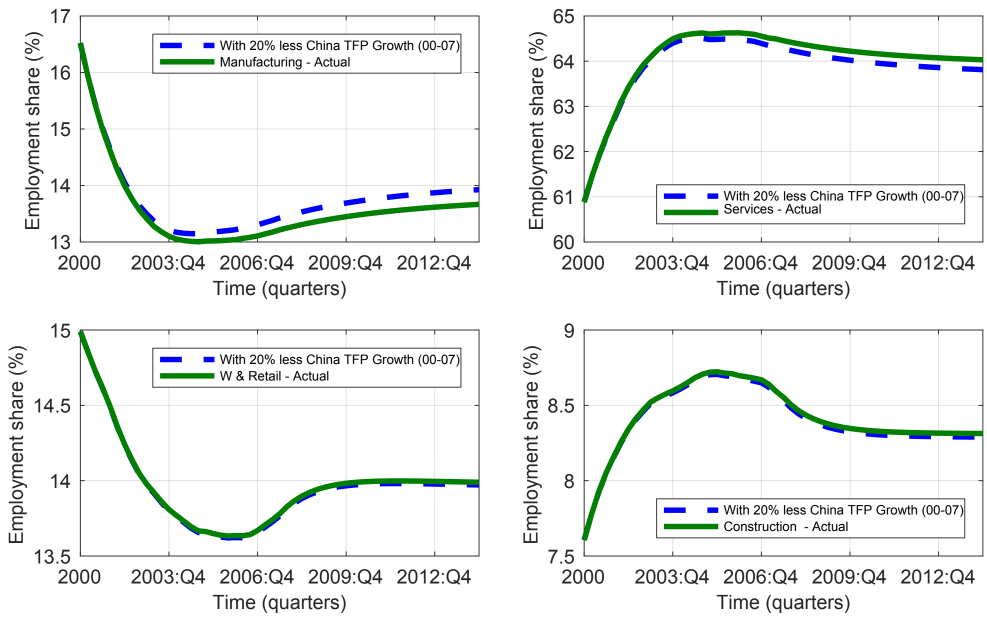

Figure 21: The evolution of employment shares (Example 3)

Note: The figure presents the evolution of employment in each sector (manufacturing, services, wholesale and retail, and construction) over total employment. Total employment excludes farming, utilities, and the public sector. The dashed lines represent the shares computed from a counterfactual with all the actual changes in fundamentals except for 20% less growth in China's fundamental TFP per year relative to the actual growth in China's TFP over the period 2000-2007. The solid lines represent the shares from the actual economy.

explaining about 27% of the total increase, followed by the metals, furniture, and textile industries, which together explain about 45% of the increase.

Figure 24 shows the regional contributions to the increase in U.S. manufacturing employment. California explains about 10% of the total increase in manufacturing employment, followed by Texas which explains about 8.5%.

In Figure 25, we study the local impact of 20% less productivity growth in Chinese manufacturing industries by normalizing the regional contributions by the regional employment shares. We find that the local impact on larger, more-diversified states, such as California and Texas, is smaller relative to that on smaller, less-diversified states, such as Mississippi, North Carolina, and South Carolina.

We now turn to the results for non-manufacturing industries. Figure 26 presents the contributions of different industries and Figure 27 presents the contributions across states to the total decline in non-manufacturing employment. Starting with Figure 26, besides the category other services industry, the health industry is the largest contributor among services industries, accounting for about 21% of the total decline, followed by the education, transport services, and construction industries, which account for about 10%

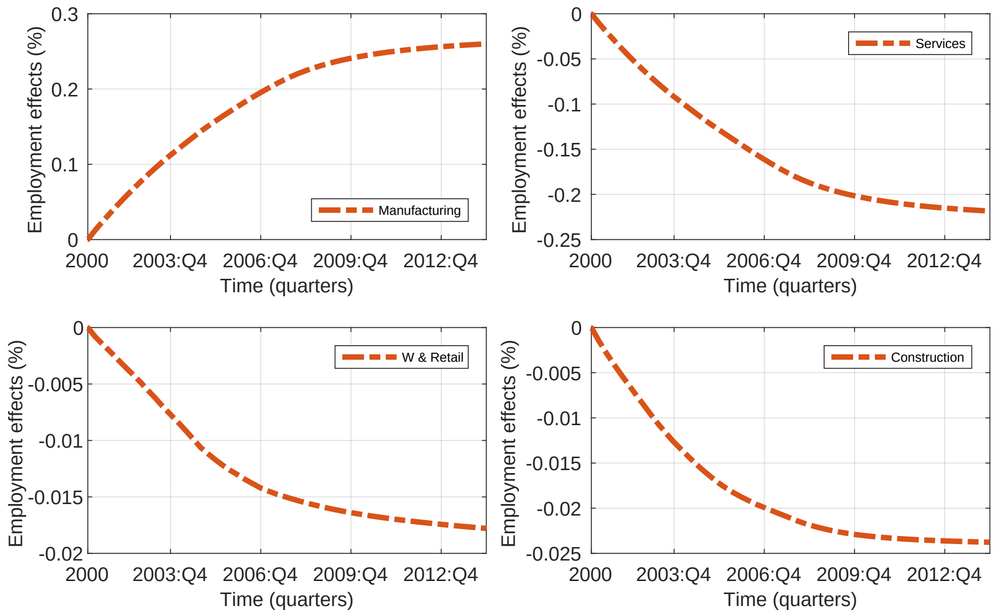

Figure 22: Counterfactual effects on employment shares (Example 3)

Note: The figure presents the effects, measured as the change in employment shares by sector (manufacturing, services, wholesale and retail and construction) over total employment, computed from a counterfactual with all the actual changes in fundamentals except for a 20% less growth in China's fundamental TFP per year relative to the actual growth in China's TFP over the period 2000 to 2007.

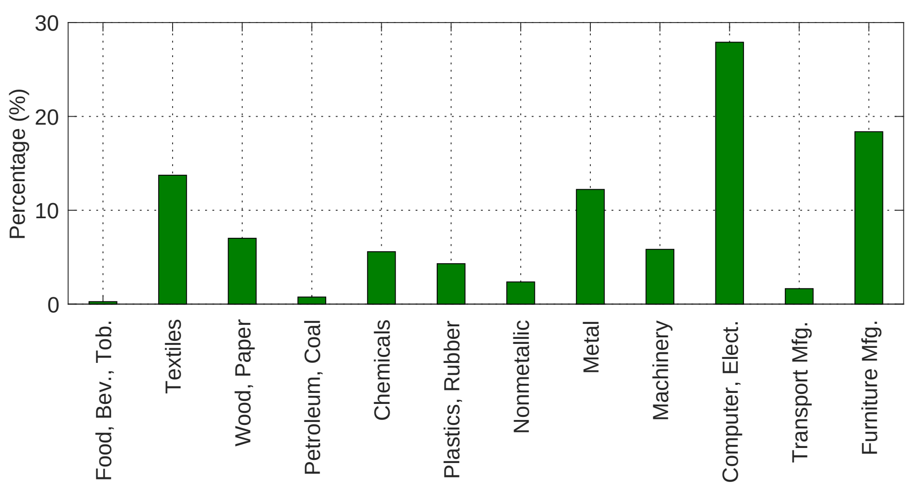

Figure 23: Manufacturing employment increases (percent of total)

Note: The figure presents the contribution of each manufacturing industry to the total increase in manufacturing employment. The results are computed from a counterfactual with all the actual changes in fundamentals except for 20% less growth in China's fundamental TFP per year relative to the actual growth in China's TFP over the period 2000-2007.

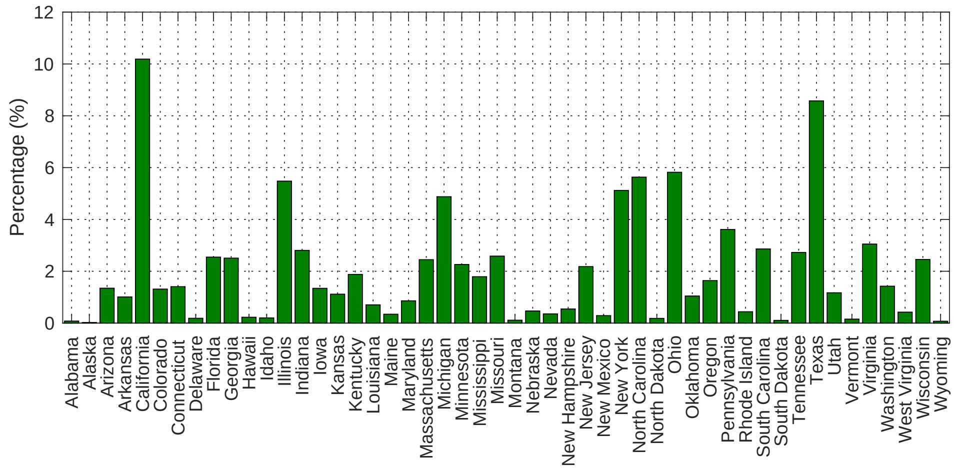

Figure 24: Regional contributions to the aggregate U.S. manufacturing employment increase (percent)

Note: The figure presents the contribution of each state to the total increase in employment in the manufacturing sector. The results are computed from a counterfactual with all the actual changes in fundamentals except for 20% less growth in China's fundamental TFP per year relative to the actual growth in China's TFP over the period 2000-2007.

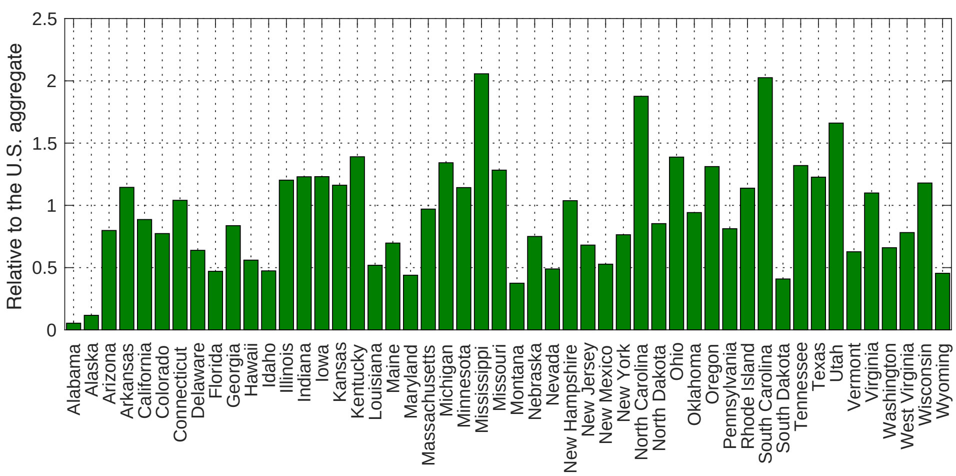

Figure 25: Regional contributions to aggregate U.S. manufacturing employment increase normalized by regional employment share

Note: The figure presents the contribution of each state to the aggregate U.S. increase in manufacturing employment normalized by the employment of each state relative to U.S. aggregate employment. The results are computed from a counterfactual with all the actual changes in fundamentals except for 20% less growth in China's fundamental TFP per year relative to the actual growth in China's TFP over the period 2000-2007.

contribution each. Figure 27 shows that the states with a larger service sector such as California and New York contribute more to the total decline in non-manufacturing em-

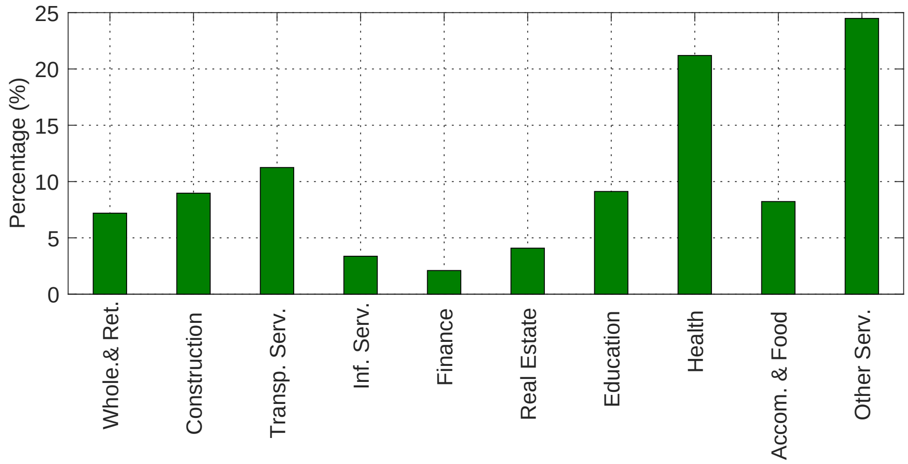

Figure 26: Non-manufacturing employment declines (percent of total)

Note: The figure presents the contribution of each non-manufacturing sector to the total decline in non-manufacturing employment. The results are computed from a counterfactual with all the actual changes in fundamentals except for 20% less growth in China's fundamental TFP per year relative to the actual growth in China's TFP over the period 2000-2007.

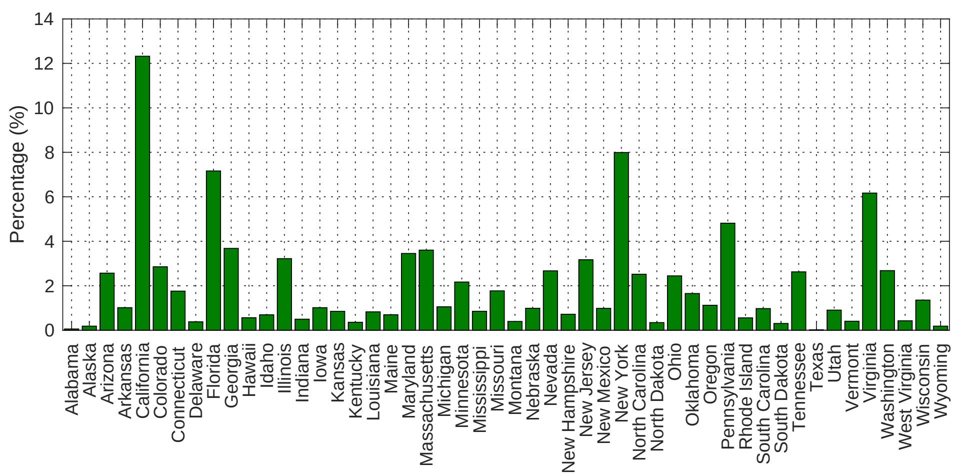

Figure 27: Regional contribution to the aggregate U.S. non-manufacturing employment decline (percent)

Note: The figure presents the contribution of each state to the total decline in non-manufacturing employment. The results are computed from a counterfactual with all the actual changes in fundamentals except for 20% less growth in China's fundamental TFP per year relative to the actual growth in China's TFP over the period 2000-2007.

ployment. In particular, the largest contributor is California, accounting for about 12% of the total decline, followed by New York, which accounts for about 8%.

EXAMPLE 4. STUDYING THE EFFECTS OF ACTUAL CHANGES IN FUNDAMENTALS

4.1. *With constant fundamentals, what is the impact of the actual China shock?*

We now quantify the dynamic effects of China's import competition on the U.S. economy with constant fundamentals. We first compute the dynamic model, holding all fundamentals constant, which is our baseline economy. We do this using the results from Proposition 2, assuming that agents foresee constant fundamentals over time, as we did in Example 1. We then use the results from Proposition 3 and solve for the changes in equilibrium allocations due to the China shock. Different from the previous example, in order to perform this counterfactual, we need to measure the *changes in fundamentals* that we want to study; in this case the changes in fundamentals that define the China shock.

One way to obtain these measurements is to use estimates from the literature. Another approach is to use the model to estimate the changes in fundamentals. In either case, the next section presents an example of how to apply our method to evaluate the effects of actual changes in fundamentals. Before doing so, we briefly describe our approach to measuring the China shock for this particular counterfactual example.

4.1.1. *Measuring the China trade shock*

One alternative for studying the economic effects of the China shock is to use estimates of changes in Chinese manufacturing TFP computed by national agencies. Unfortunately, such estimates are not readily available for our level of aggregation and time period. As a result, we follow a different route and compute the changes in productivities in China in manufacturing industries that match the changes in U.S. imports from China for the years 2000 to 2007. Of course, the changes in imports over this period could have been the consequence of factors other than changes in Chinese productivity. To deal with this, we rely on the identification strategy proposed by ADH. Section 4.1 in the main text presents further details.

Concretely we solve for the change in China's TFP in our 12 manufacturing industries $\{\hat{A}_t^{China,j}\}_{j=1,t=2000}^{12,2007}$ such that the model-predicted imports match the imports from China from 2000 to 2007 predicted by the first-stage ADH regression. Different from Section 4.1 in the main text, the model we use to measure the changes in productivities in China has a baseline economy with constant fundamentals and a counterfactual economy where agents expected constant fundamentals but Chinese TFPs unexpectedly grew. Our loss function is the sum of squared differences between the model-implied changes in U.S. imports from China from 2000 to 2007 and those predicted by the ADH first-stage regression. This procedure takes time given the high dimensionality of our problem. We use as a starting guess the changes in Chinese manufacturing productivities that solve a static version of our model. Using this as an initial condition turns out to be a smart guess. Figure 28 shows the predicted change in U.S. manufacturing imports from China

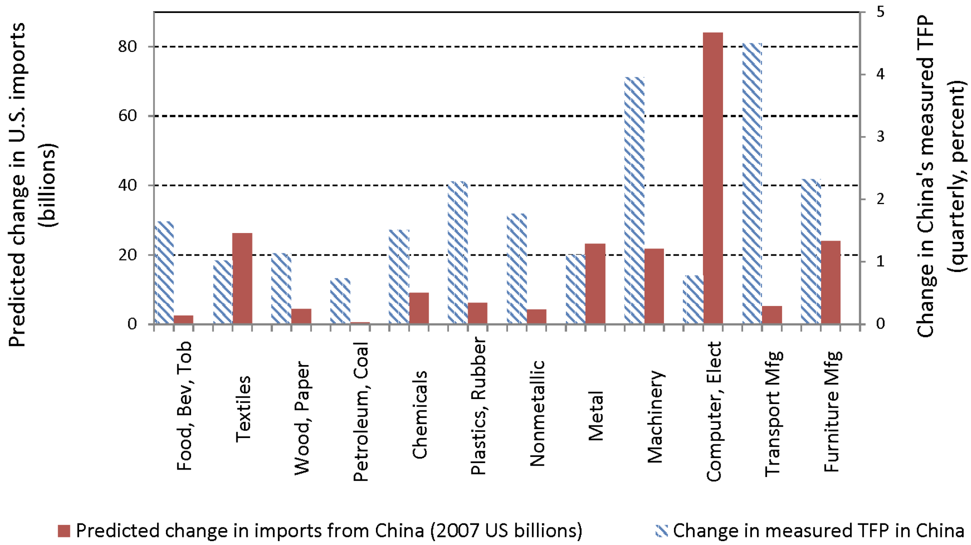

Figure 28: Predicted change in imports vs. China's TFP changes (2000-2007)

Note: The figure presents the predicted changes in imports using the ADH specification and the estimated changes in China's TFP by sector for the period 2000-2007.

computed as in ADH and the implied sectoral productivity changes in China.

4.1.2. *Results*

Starting with sectoral employment, Figure 29 presents the dynamic response of employment shares due to the China shock with all other fundamentals constant. In particular, the figure shows the difference between our baseline economy with constant fundamentals and a counterfactual economy with the actual changes in productivities in China.

The upper-left panel in Figure 29 shows the transitional dynamics of manufacturing employment due to the China shock. The figure shows that import competition from China contributed to a decline in the share of manufacturing employment of about 0.5 percentage points in the long run.

As shown in the other three panels of Figure 29, increased import competition from China leads workers to relocate to other sectors; thus, the share of employment in the services, wholesale and retail, and construction industries increases. We also find that Chinese competition reduced the U.S. non-employment rate by 0.25 percentage points in the long run. The role of intermediate inputs and sectoral linkages is crucial to understanding these relocation effects. Import competition from China leads to decreased production among U.S. manufacturing sectors that compete with China, but it also affords the U.S. economy access to cheaper intermediate goods from China that are used as inputs in non-manufacturing sectors. Production and employment increase in the non-manufacturing sectors as a result. Moreover, the increase in employment in these sectors more than offset the decline in manufacturing employment so that the non-employment rate decline.

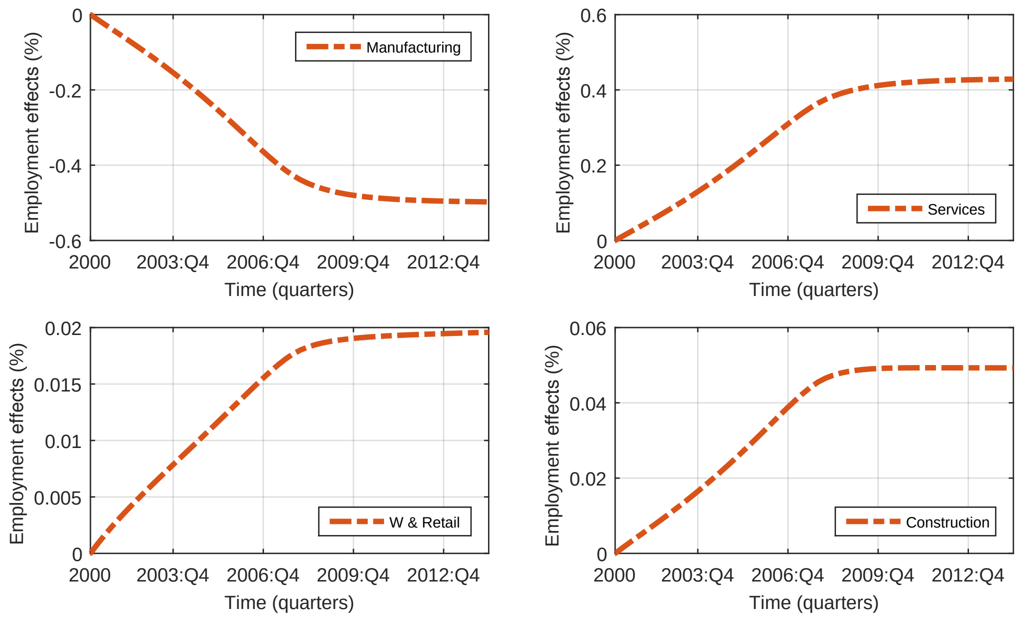

Figure 29: Counterfactual effects on employment shares (Example 4)

Note: The figure presents the effects, measured as the change in employment shares by sector (manufacturing, services, wholesale and retail, and construction) over total employment, from a counterfactual without the China shock and constant fundamentals relative to the economy with the China shock and constant fundamentals.

Finally, employment in construction declines a bit in the short run after the China shock, which is explained, as mentioned earlier, by the fact that the economy was transitioning to a steady state when the change in Chinese productivity hit the U.S. economy. In the long run, we find that about 75 thousand jobs were created in construction as a result of the China shock.

Figure 30 presents the dynamic response of the shares of employment both with and without the China shock. As discussed above, there are transitional dynamics toward a steady-state equilibrium even in the absence of any change in Chinese productivity, and these dynamics occur because the economy is not in a steady state in the year 2000.

We now quantify the relative contributions of different sectors and regions to the decline in the manufacturing employment due to the China shock. Figure 31 shows the contribution of each manufacturing industry to the total decline in manufacturing employment. Industries with higher exposure to import competition from China lost more employment. The computer and electronics and furniture industries contributed to about half of the decline, followed by the metal and textiles industries, which together contributed to about one-fourth of the total decline. Industries less exposed to import competition from China explain a smaller portion of the decline. In fact, these industries also benefit

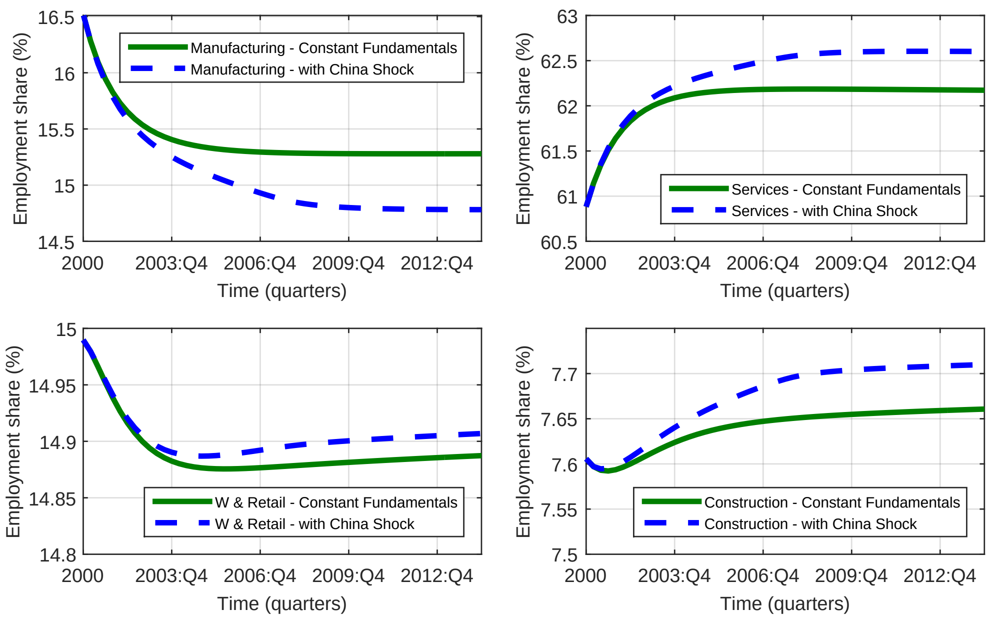

Figure 30: The evolution of employment shares (Example 4)

Note: The figure presents the evolution of employment in each sector (manufacturing, services, wholesale and retail, and construction) over total employment. Total employment excludes farming, utilities, and the public sector. The solid lines represent the shares from the baseline economy with constant fundamentals, while the dashed-lines represent the shares from the economy with the China shock.

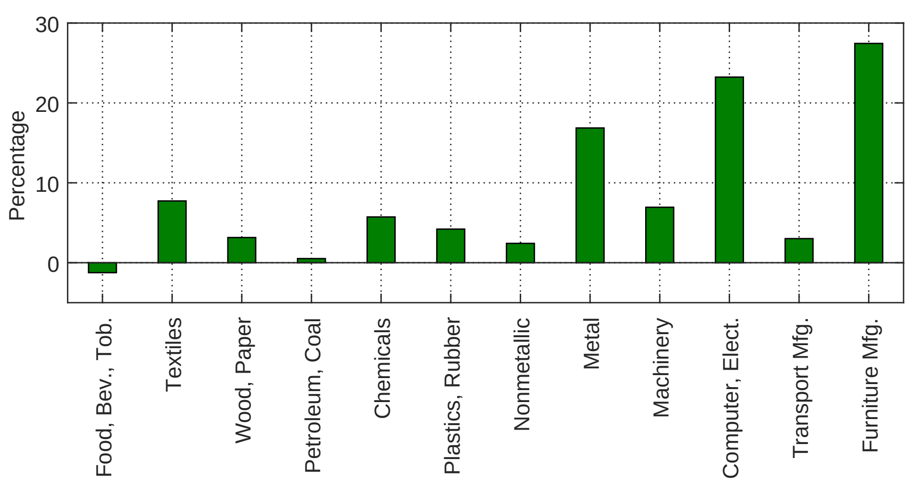

Figure 31: Manufacturing employment declines due to the China trade shock (percent of total)

Note: The figure presents the contribution of each manufacturing industry to the total reduction in manufacturing employment due to the China shock.

from access to cheaper intermediate goods from industries that experienced a substantial productivity increase in China. In some industries, such as food, beverage, and tobacco, increased production from access to cheaper intermediate goods more than offset the negative effects of increased import competition, and employment increased as a result.

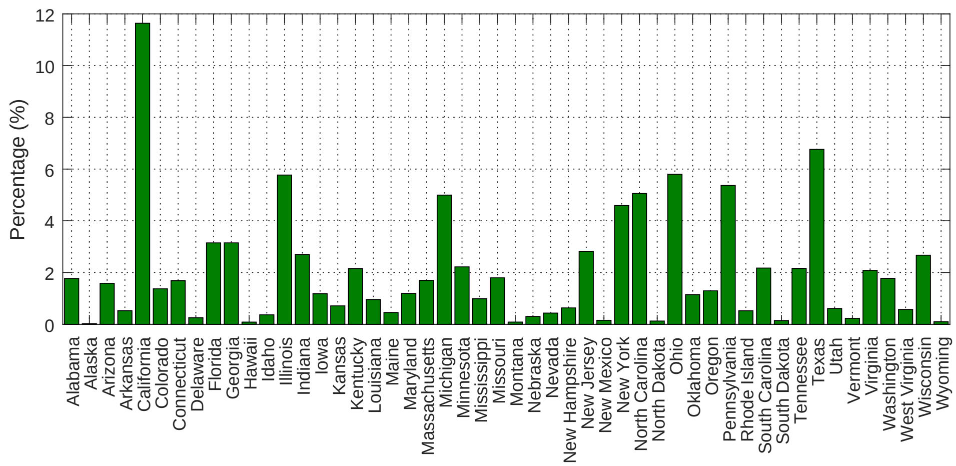

Figure 32: Regional contribution to aggregate U.S. manufacturing employment decline (percent)

Note: The figure presents the contribution of each state to the total reduction in manufacturing employment due to the China shock.

As discussed in the main text, the fact that U.S. economic activity is not equally distributed across space, combined with its differential sectoral exposure to China, implies that the impact of import competition from China on manufacturing employment varies across regions. Accordingly, Figure 32 presents the regional contributions to the total decline in manufacturing employment. Similar to the results in the main text, states with a comparative advantage in industries more exposed to import competition from China lose more employment in manufacturing. As a result, California, which comprises a large fraction of the employment in the computer and electronics industry, contributed the most to the overall decline in manufacturing employment (about 12%) followed by Texas. The employment in states with a comparative advantage in goods that were less affected by import competition from China and in states that benefited from the access to cheaper intermediate goods was impacted less.

It is also informative to study the local impact of the China shock. Figure 33 displays the state contribution to the total decline in manufacturing employment normalized by the employment share of the state in the U.S. economy. In the figure, a number greater than 1 means that the local change in manufacturing employment share is larger than the national change (-0.5 percentage points). As we can see from the figure, the local impact of the decline in manufacturing employment in states such as South Carolina and North Carolina was bigger than the impact on the whole U.S. economy. The figure also

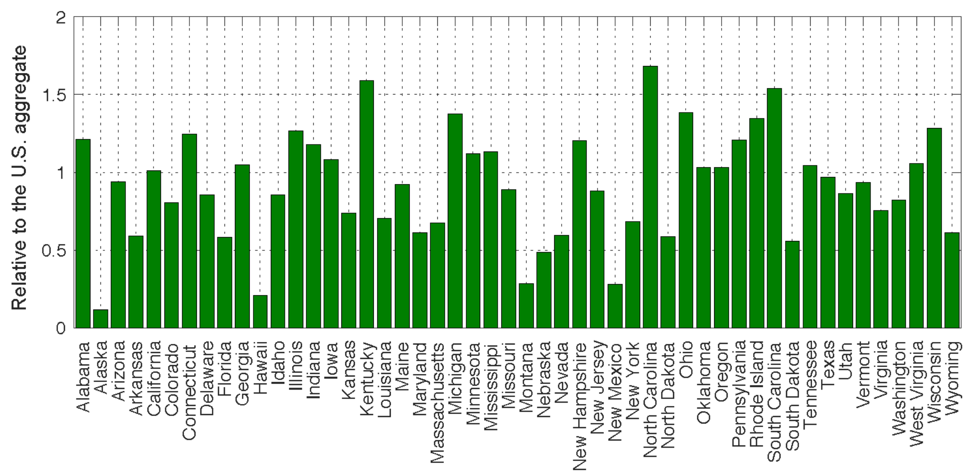

Figure 33: Regional contribution to aggregate U.S. manufacturing employment decline normalized by regional employment share

Note: The figure presents the contribution of each state to the reduction in aggregate U.S. manufacturing employment due to the China shock, normalized by the employment of each state in aggregate U.S. employment.

shows that in bigger, more-diversified states, such as California and Texas, the decline in manufacturing employment as a share of state employment is similar to the aggregate U.S. decline in manufacturing employment.

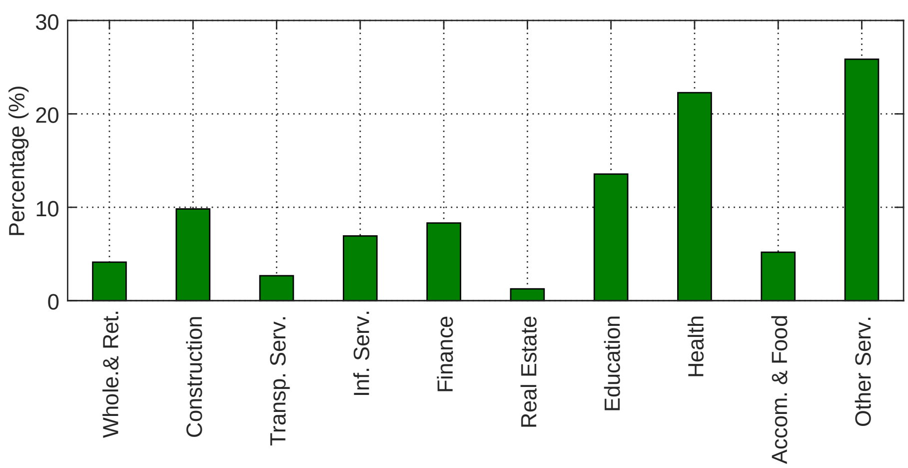

Figure 34: Non-manufacturing employment increases due to the China trade shock (percent of total)

Note: The figure presents the contribution of each non-manufacturing sector to the total increase in non-manufacturing employment due to the China shock.

We now turn to the sectoral and spatial distribution of the employment gains in the non-manufacturing industries due to the China shock. The sectoral contribution to the change in non-manufacturing employment is displayed in Figure 34. As we can see, all non-manufacturing industries absorbed workers displaced from manufacturing industries. In particular, besides the other services industry, the health and education industries experience the largest gains among service industries, accounting for about 35% of the total increase, followed by the construction industry with 10%. Figure 35 shows that U.S. states with a larger service sector contribute more to the increase in non-manufacturing employment, as they were able to absorb more workers displaced from manufacturing industries. Specifically, New York absorbed the most, accounting for about 9% of the total increase, followed by California, which accounts for about 8%.

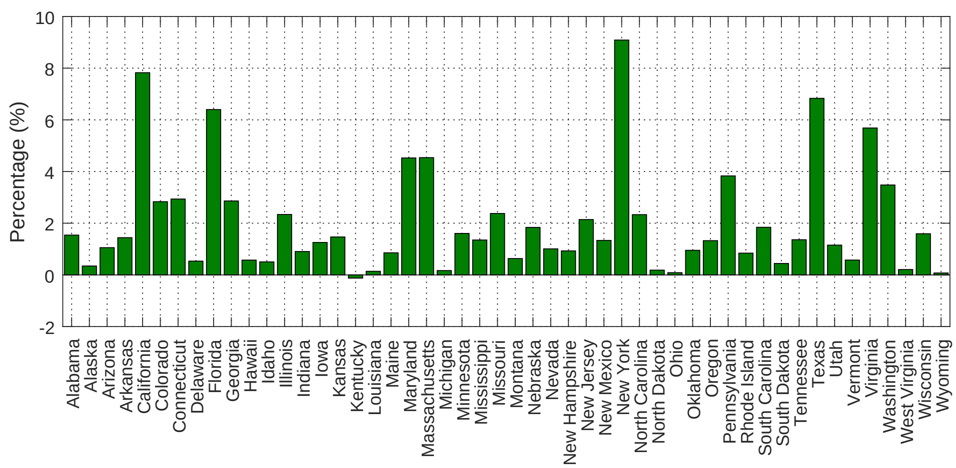

Figure 35: Regional contributions to aggregate U.S. non-manufacturing employment increase (percent)

Note: The figure presents the contribution of each state to the total rise in non-manufacturing employment due to the China shock.