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**The “China Shock” revisited: Insights from value added trade  
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# The “China Shock” revisited: Insights from value added trade flows\*

Adam Jakubik<sup>†</sup>      Victor Stolzenburg<sup>‡</sup>

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## Abstract

We exploit a decomposition of gross trade flows into their value added components to reassess the relationship between increased imports from China and manufacturing jobs in US local labour markets following the seminal paper of Autor, Dorn, and Hanson (2013, ADH). Decomposed trade flows enable us to address identification and measurement issues inherent to gross trade data. In particular, it allows us to remove US value added in Chinese exports from the exposure measure which is mechanically correlated with the dependent variable and overstates the volume of the trade shock. In addition, the decomposition permits to correct for double counting, to remove primary and services inputs in manufacturing exports, and to assign competition to the upstream industry that supplied the value added rather than the final exporting industry. This further reduces the volume of the shock and improves the accuracy of the import exposure measure. Consequently, we find considerable differences in the pattern of regions that are most affected by the trade shock and show that imports from China can explain less of the decline in US manufacturing than what gross trade data would suggest. We then separate the shock into a China-driven domestic reform and a third-country-driven value chain component, and find in line with ADH that the smaller, but still negative labour market effects are indeed China driven. Finally, we observe that the negative effects identified in ADH are not present in the 2008-2014 period, as labour market adjustment has largely concluded. The long time needed for adjustment may have been prolonged by the evolution of China’s comparative advantage.

**Keywords:** value added trade, labor-market adjustment, local labor markets

**JEL Classification:** E24; F14; F16; J23; L60; R23

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# 1 Introduction

The reintegration of China into the world trading system has been an extraordinary historical achievement that has lifted millions of people out of poverty. It has also set in motion monumental shifts in world trading patterns which provide a unique opportunity to examine the effects of trade policy. This research has found evidence of lower prices and greater investment in innovation due to trade with China (Feenstra and Weinstein, 2017; Amiti et al., 2017; Bloom et al., 2016; Impullitti and Licandro, 2018). On the flip side, trade liberalisation necessitates adjustments in both factor and product markets. As is the case with adjustment due to technological progress or changes in consumer tastes, some individuals will be worse off than before and can face significant adversities in transitioning from job to job. While the gains from trade through lower prices are relatively evenly distributed throughout the US, the patterns of geographical clustering typical of manufacturing industries cause local communities to be asymmetrically affected by import competition. Highly influential research by Autor et al. (2013, henceforth ADH) shows that US local labour markets more exposed to increased import competition from China have seen significant losses in jobs and earnings relative to less exposed labour markets. These effects have also been shown to be present in other advanced economies such as Spain, Norway, and France (Donoso et al., 2015; Balsvik et al., 2015; Malgouyres, 2016).

Although recent research suggests that these negative effects are not present at the national level, and that the cost savings made possible by trade with China have actually helped industries retain workers on aggregate (Caliendo et al., 2015; Magyari, 2017; Wang et al., 2017), this does not diminish the significance of the fact that in many locations US manufacturing industries have suffered, and further research by Adda and Fawaz (2017) and Autor et al. (forthcoming) show negative effects in other areas of life of those affected, such as health and marriage prospects. The localised pain felt by those adversely impacted has started to feed into the political process and has shaped the discourse on trade at a national level. Colantone and Stanig (2016) show that the vote for Brexit was influenced by import competition from China, and Autor et al. (2017) present evidence on trade with China contributing to the polarisation of US politics. In light of these developments, researchers and policy makers have emphasized the need for adjustment policies, such as place-based or mobility policies, in order to secure the net welfare gains from trade while minimizing the hardship for locations and individuals who are affected negatively by trade (IMF, World Bank, WTO, 2017; WTO, 2017; Austin et al., 2018). For such policies it is crucial to correctly identify which regions and sectors are exposed to import competition and to what extent.

In this paper, we firstly show that the statistical concept of trade in value added can greatly enhance the accuracy of import competition measures with important consequences for the spatial distribution and the magnitude of trade shocks. Moreover, value added decomposed trade flows further allow us to correct for a mechanically endogenous component of the exposure measure, namely US value added in Chinese exports, and to distinguish between the impact of China-specific drivers of the trade shock and that of third countries who use China in final stages of their production but provide much of the value added. The final contribution of this paper is to explore the length of adjustment and how changes in China's comparative advantage over time

may have prolonged the employment effects.

We address these questions by exploiting data from Inter-Country Input-Output tables (ICIOs) covering the time period from 2000 to 2015. This expands the time-period analysed by ADH to shed light on whether the negative effect of Chinese import competition persists, and therefore whether the China shock is fundamentally different from other trade shocks with regard to adjustment time. The tables allow splitting gross imports from China into their individual value added components by origin and, thus, separate Chinese value added (which we refer to as domestic value added, DVA) in exports to the US from third country value added (foreign value added, FVA) that enters the US via China. This approach entails two important methodological improvements over the use of gross export data.

Firstly, it allows us to create a more precise measure of local labour market exposure by addressing four different measurement issues of gross imports. Goods exported from a downstream industry such as consumer electronics contain inputs from upstream industries such as plastics and fabricated metal products. Therefore, a rise in US consumer electronics imports might actually affect local labour markets which depend on plastics or fabricated metal products. For instance, let us assume that ten people are required to produce a mobile phone but only five of them actually work in the electronics industry while the other five are employed by the glass, plastics and other upstream industries that are located elsewhere. This means that when a mobile phone is imported, gross trade data incorrectly assigns 50% of the competition by assigning it fully to the electronics industry and the local labour markets where that industry is represented. In addition, gross imports hide the fact that certain upstream production stages of imported goods might still be performed at home. Using the mobile phone as example, it might be that two employees are in charge of high-tech components and while the other stages are off-shored, high-tech production stages remain domestic. In this case gross trade data would overstate exposure by 20%. Similarly, many goods are dependent on primary and services inputs and as long as the focus is on manufacturing employment as in this paper or ADH, such inputs should be excluded which is possible with value added data. Finally, in the age of value chains gross trade data suffers from double counting when intermediates cross the same border twice. If for example, China produces phone cases and ships them to the US where high-tech components are inserted before the phone travels back to China for final assembly, then the phone case would be counted twice by gross trade data. By looking at the value added content of US imports from China, we can address these four issues and correctly assign the imports to the local labour markets that are ultimately affected.

The second methodological improvement relates to another measurement issue, namely US value added in Chinese exports. Value added trade data allows us to better control for the endogeneity of import exposure by removing the US value added component in Chinese exports. Since US employment is a major contributor to US value added in Chinese exports, there is a mechanical correlation between import exposure and employment in manufacturing. This mechanical correlation is not addressed by the instrumentation strategy of ADH since US value added is also present in Chinese exports to other high-income countries. By removing this part of Chinese exports, we improve the validity of the instrument. Johnson and Noguera (2012) show that the

US value added content in Chinese exports is considerable which highlights that this adjustment is quantitatively meaningful and relevant.

Turning to our results, we find that using value added instead of gross trade flows changes the geography of import competition considerably. As expected, locations specialized in downstream industries, in particular electrical machinery and electronic equipment, are much less exposed to import competition than what gross imports would suggest while the opposite hold for certain locations specialized in upstream manufacturing including steel. Two of our most extreme cases in this regard are San Jose, California, home to Silicon Valley and many of the US' main electronic equipment manufacturers, and North-West Indiana, home to the largest steel mill in the US and large aluminum producers. In these commuting zones, import competition in value added terms is more than a standard deviation different from gross import exposure. In the case of San Jose the exposure decreases while it increases for North-West Indiana. These intuitive results highlight the need to take value added data into account when assessing the geography of trade shocks and when designing policy responses, in particular when these policies are place-based. They also facilitate our understanding of current trade policy developments since they align import competition more closely with certain recently introduced trade policy measures.

Next, we find that Chinese import competition can explain less of the US manufacturing decline than previously considered. As using value added imports effectively reduces measurement error which biases estimates towards zero and corrects for an upward bias introduced by endogeneity, we observe that the corresponding coefficient on Chinese imports increases substantially compared to the coefficients obtained using gross import data. This speaks in favour of a larger role of imports. However, since the total volume of the shock is significantly smaller once double counting, US value added, and primary and services inputs are excluded, we find that the total number of jobs affected is in fact smaller than the corresponding gross trade number by 32.3%, despite the increased coefficient. This suggests that China has been relatively less important for the decline of US manufacturing than what ADH find using gross trade flows.

Regarding the drivers behind the employment effects, we find that China-specific changes as suggested by ADH are dominant. Autor et al. (2016) discuss extensively the domestic reforms which took place in China that enabled it to integrate into the globalised economy as a manufacturing powerhouse. At the same time, Johnson and Noguera (2016) and Koopman et al. (2012) research the proliferation of Global Value Chains (GVCs) and in particular the participation of China. Implications for US trade policy depend on the extent to which employment effects are caused by China-specific drivers as opposed to GVCs since the latter tend to be highly mobile and can reroute if faced with bilateral trade policy interventions. Our results show that for the period 2000-2008 increased exposure to Chinese value added is associated with a relative decline in local manufacturing employment, whereas exposure to foreign value added in Chinese exports has a positive effect, albeit not statistically significant. This means that US employment adjustments are caused by China-specific changes and not by indirect imports consistent with a GVC-driven explanation. The result for foreign value added suggests that other advanced economies such as Japan and Korea re-routing exports via China does not harm US manufacturing. This is potentially explained by lower prices of goods that have been previously imported by the US

directly from these countries boosting total demand without requiring significant new labour market adjustment in the industries affected. This hypothesis is in line with the fact that most of foreign value added in Chinese exports to the US originates in high-income countries which have traded intensively with the US before the rise of China. An alternative hypothesis is that foreign value added is associated more with horizontal intra-industry trade and Chinese value added with vertical intra-industry trade as defined by Greenaway et al. (1995), and hence the former necessitates relatively little labour market adjustment.

Finally, we find that in the period from 2008-2014 the negative effects of local exposure to Chinese value added are no longer present. The corresponding coefficients in this latter period are no longer statistically significant, implying that the China shock today is not driving regional differences in manufacturing employment. We further split the Chinese value added exposure along three industry groups to determine if the negative impact is driven by a particular subset of industries. Specifically, the three groups comprise industries in which China has had a comparative advantage since 1995, industries in which China had gained a comparative advantage between 1995 and 2008, and industries in which China has had a comparative disadvantage between 1995 and 2008. We find that in the period 2000-2008 exposure to value added from the first two groups is associated with negative effects on local manufacturing employment, however, in 2008-2014 these are no longer statistically significant. This implies that adjustment has taken place in industries where China has had or relatively recently gained a competitive edge, and that it has concluded. Exposed occupations and firms have contracted or adapted successfully, leaving the surviving manufacturing occupations and firms largely resistant to a further increase in import competition. While the adjustment period estimated by ADH of about 10 years from the mid-1990s to 2007 is fairly long, this is consistent with the concurrent evolution of China's comparative advantage to encompass more complex and skill intensive manufacturing industries. We conclude that policy measures aimed at limiting imports from China cannot be vindicated by the aim of protecting manufacturing employment.

The rest of this paper is organised as follows. Section 2 reviews the related literature, Section 3 discusses the data followed by Section 4 on the empirical strategy, Section 5 presents the econometric results, and Section 6 concludes.

## 2 Related Literature

Our work is directly related to the seminal paper by ADH and papers that replicate their methodology (e.g. Dauth et al., 2014; Balsvik et al., 2015; Malgouyres, 2016). Our methodological contribution to this line of research is to improve upon the identification as well as the precision of the exposure measure by considering also the upstream industries and countries that contribute value added to the final product whose industry is recorded in the gross trade statistics.

In addition, our work is similar in spirit to Shen and Silva (2018) who also adopt a value added perspective. Rather than studying the value added decomposition of bilateral gross trade flows, they view the impact of the rise of China through a different lens, focusing on all the Chinese value

added that is eventually absorbed by the US. That is, they exclude foreign value added in Chinese exports to the US but consider instead also the Chinese value added embedded in third country exports to the US. For instance, China might export processed rare earth elements to Japan for the production of semiconductors which are then exported to the US. In technical terms, the value added decomposition we use employs backward linkages whereas their's employs forward linkages. While this is a very valuable exercise, their decomposition is not suited to provide insights for bilateral trade policy and does not allow for a direct comparison to the results by ADH who, like us, look at bilateral trade flows.

Similar to our paper, more recent work on the impact of Chinese imports emphasises the importance of input-output linkages (e.g. Acemoglu et al., 2016; Wang et al., 2017). Acemoglu et al. (2016) use industry level data to complement the effects of direct industry exposure with exposure which propagates downstream to a given industry's customers and exposure which propagates upstream to a given industry's suppliers. As one would expect, direct and upstream effects of exposure are found to be negative, however downstream effects are statistically insignificant. While related to our approach in spirit, they continue to rely on gross trade data to calculate the direct exposure measures and based on these direct exposure measures estimate indirect exposure using US national input-output tables. This means that the measurement and identification issues mentioned above are not addressed in their work and affect their direct and indirect measures. In contrast, like ADH, we are interested only in the direct exposure measure. By taking into account foreign, as opposed to US, input-output linkages we are able to capture the direct exposure effects more precisely by shifting some import competition to the upstream industries that are affected. However, this still only relates to direct exposure and is thus not comparable to the approach in Acemoglu et al. (2016) or Wang et al. (2017), who define direct exposure similarly. In contrast to Acemoglu et al. (2016), Wang et al. (2017) find statistically significant positive downstream effects since they calculate downstream exposure using imports of only intermediate goods and services. Once effects on services sectors are taken into account, they find that the net effect of trading with China on local employment is modestly positive.

The effects we identify here are but one side of the coin of trade liberalisation: the necessary local labour market adjustment. Magyari (2017) broadens the focus by studying the effects on US manufacturing employment at a firm level, cutting across local labour markets. She finds that US firms involved in manufacturing record net gains in jobs in response to increased Chinese import competition. While specific units of production within the firm shrink, others, in sectors where the US has a comparative advantage relative to China experience employment growth. These results are attributed to firms reorganising production and a favourable cost shock in the form of cheaper Chinese inputs. This does not contradict the significant effects found at a local labour market level or indeed the adjustment costs faced by individual workers, rather, this methodology is suited to assess the aggregate effects of a trade shock, which are equally important to consider from a policy perspective.

In one of the earliest papers in trade to apply this type of identification strategy, Topalova (2007) emphasises that this methodology is suited to identify short- and medium-run effects at the local level. Rather than identifying the effects of the treatment, in our case the China shock,

on the national aggregate levels of the outcome variable, the focus is on identifying differential regional effects based on regional variation in the level of treatment exposure. The fact that manufacturing employment is reduced more in local labour markets that are more exposed to import competition is a good indicator of the locally borne costs of trade adjustment, which are greatly important for domestic policy, as discussed earlier. However, it is not informative about the causal effects of the China shock on the manufacturing employment share at a national level, much less about aggregate welfare implications in general equilibrium, which are more relevant questions from a trade policy angle.

### 3 Data Description

We use value added decomposed trade flow data covering the years 2000 and 2007 generated from the OECD ICIOs and based on the accounting framework proposed by Koopman et al. (2014) and further disaggregated to a bilateral-sector level by Wang et al. (2013). The database covers 61 countries and 34 industries.<sup>1</sup> We prefer TiVA compared to alternative datasets since OECD and WTO have used elaborate techniques to deal with China's processing trade. Due to China's outstanding role in GVCs and processing trade, this implies a significant improvement for the reliability of the data. As the OECD ICIOs currently only extend to 2011, we use for some regressions data for the years 2000, 2008, and 2015 generated from the Asian Development Bank multi-regional input-output tables (ADB-MRIO) and provided by the Research Centre on GVCs at the University of International Business and Economics in Beijing.<sup>2</sup>

For robustness exercises we also use equivalent data from the 2016 release of the World Input-Output Tables (WIOT 2016), however the ADB-MRIO is preferred because compared to WIOT 2016 it contains 5 additional Asian economies, and since the focus of this research is on the sources of value added in Chinese exports, accurately measuring input-output linkages in the region is critical.

Our employment data is sourced from the publicly available County Business Patterns (CBP) series of the United States Census Bureau and covers the years 1990, 2000, 2007, 2008, and 2014. This data is cleaned using code made public by David Dorn<sup>3</sup>. Data on working-age population used to compute the dependent variables are sourced from the Population Estimates Program (PEP) of the United States Census Bureau. We concord our employment data to the more aggregated industry classification of our trade flow data using correspondence tables made available by the United Nations Statistics Division<sup>4</sup>.

Control variables at the local labour market level, with the exception of lagged percentage of employment in manufacturing, are the ones made public by David Dorn.

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<sup>1</sup>Note, that as a result our data is more aggregated than ADH's gross import data which is aggregated to 4-digit SIC industries. We show in robustness exercises that this does not drive our results.

<sup>2</sup>For future research, we plan to run value added decompositions for more recent years also on TiVA as this data becomes available.

<sup>3</sup><http://www.ddorn.net/>

<sup>4</sup>ISIC Rev.3 - US SIC 87 correspondence, <https://unstats.un.org/unsd/cr/registry/regdnld.asp?Lg=1>



## 4 Empirical Strategy

### 4.1 Identification and Instrumentation

Our empirical approach builds on the methodology developed by ADH with the aim to deepen our understanding of the local labour market effects of the US-China trading relationship.<sup>5</sup> In this approach, the identification strategy relies on the fact that the US can be divided into 722 regional markets, termed commuting zones (CZs). Within commuting zones labour is mobile and across them it is highly immobile. This is a key assumption, because if labour were mobile also across CZs, the effects of trade shocks would not be identifiable at a local labour market level. It is thus worth noting that the literature finds support for this assumption (Topel 1986; Blanchard and Katz 1992; Glaeser and Gyourko 2005). These CZs are then subject to differential trade shocks determined by their initial patterns of industry specialisation.

We use a measure of CZ trade exposure created in the spirit of ADH but based on value added imports from China to the US:

$$\Delta EXP_{it} = \frac{1}{L_{it}} \sum_s \frac{L_{ist}}{L_{st}} \Delta IMP_{st}. \quad (1)$$

The above expression represents the change in exposure,  $EXP$ , for a particular CZ  $i$  with the base year  $t$ . It is normalised per worker. The change in imports,  $IMP$ , from each exporting sector  $s$  is weighted by the national prominence of the CZ in the sector, using the CZ's share of total US employment,  $L$ , in that sector. In our analysis, our benchmark specifications measure  $IMP$  as the value added provided by sector  $s$  embedded in the imports of any other sector. For comparison with previous work, other specifications use the conventional gross value of imports  $IMP$  by exporting sector  $s$ .

The issue of potential endogeneity stemming from the correlation of both employment outcomes and imports with unobservable and omitted demand shocks is addressed by instrumenting the exposure measure with an analogous one where employment is lagged by one period and US imports from China are replaced by imports from a group of other developed countries.

We estimate the specification in Equation 2, that is we regress  $\Delta MANUF_{it}$ , the change in the share of manufacturing employment in the working-age population of CZ  $i$  on the change in local trade exposure,  $\Delta EXP_{it}$ . We depart from ADH in that rather than using a stacked first differences model we only use the one time period for which we have overlapping data, specifically 2000-2007.

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<sup>5</sup>We are interested in precisely identifying the causal effects on manufacturing employment through the import competition channel, so we do not seek to simultaneously include a treatment variable for downstream exposure to intermediate goods in order to identify input price effects. Industries which are downstream from the imported product presumably benefit, so the expected effect would be positive. For example, Topalova and Khandelwal (2011) show that trade liberalisation leads to some firm level efficiency gains due to import competition but much bigger gains due to increased access to foreign inputs. Furthermore, our identification strategy is agnostic about the employment effects, whether positive or negative, through the aggregate demand channel, which is not locally determined, as well as welfare effects more generally. Therefore, our conclusions are most relevant not for trade policy but for employment policies, particularly those aimed at facilitating adjustment to shocks.

$$\Delta MANUF_{it} = \beta_0 + \beta_1 \Delta EXP_{it} + \mathbf{X}'_{it} \gamma + \epsilon_{it} \quad (2)$$

## 4.2 Value Added Exposure

If trade adjustment policies are to be implemented, it is important to correctly identify the industries and local labour markets affected by import competition. It is here that trade in value added statistics come into play. By accounting for input-output linkages on the supply side they allow us to identify the industries and countries which contribute value added to the production of a manufactured good. This information enables us in turn to create a more precise measure of local labour market exposure.

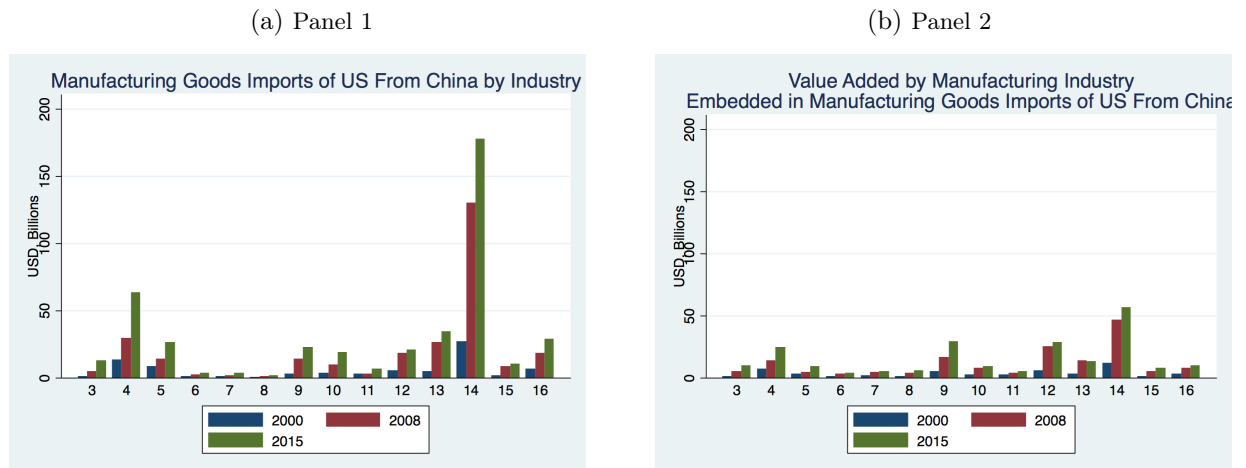
The reason is that gross trade data assigns a substantial amount of import competition to wrong labour markets due to four issues. Firstly, goods exported from a downstream industry such as consumer electronics contain inputs from upstream industries such as plastics or fabricated metal products. Therefore, a rise in US consumer electronics imports might actually affect local labour markets which depend on plastics or fabricated metal products and not only labour markets specialised in electronics. As a result, ignoring the components of a final good leads downstream labour markets to appear overexposed and upstream labour markets underexposed. Secondly, primary and services inputs account for an important share of the value of manufacturing imports, around 42.3% in 2000, but do not compete with manufacturing workers. Not removing this value added leads to overstating the exposure of local labour markets. The same holds for the double counting problem of gross trade data. The increasing complexity of production networks causes some intermediates to cross the same border several times which leads them to enter gross trade statistics several times without actually adding competition. The final issue is that a non-negligible share of US manufacturing imports from China is in fact US value added, around 6.25% in 2000, that should not be counted as competition.

In addition to misestimation, US value added in Chinese exports introduces a second identification issue. It mechanically correlates dependent and independent variable since US value added is created by US employment which is the outcome variable. This endogeneity is not addressed by the instrumentation strategy since US value added is likely to be part of Chinese exports to other high-income countries too. With value added decomposed imports we can correct for this source of endogeneity, address the overexposure problem and assign the imports to the local labour markets that are actually affected.

In Figure 1 we present a side-by-side comparison of the value of imports based on the industry of the imported good, i.e. a gross trade perspective, with the imported value added by industry. Given the focus of the literature on the decline of manufacturing industries in the US, we focus here on manufacturing goods and the manufacturing value added, so while embedded primary commodities and services value added is included in the first panel, these industries are not shown in the second panel, albeit they are also indirectly exposed. As expected, we observe that the imported value added is significantly less than the gross import value for some industries such as Textiles (4), Leather and Footwear (5), Machinery (13), Electrical and Optical Equipment (14),

and other Manufacturing and Recycling (16). The most dramatic difference is in the Electrical and Optical Equipment sector where in 2008 US imports from China were close to USD 130 billion by import value of the goods, yet only above USD 47 billion of the value added embedded in those goods came from the Electrical and Optical Equipment sector. This illustrates how using gross trade statistics may give a distorted picture of labour market exposure to import competition. In contrast to the downstream sectors listed above, we observe that for some upstream sectors which serve more often as inputs to production, such as Pulp, Paper, Printing and Publishing (7), Coke, Refined Petroleum and Nuclear Fuel (8), Chemicals (9), and Basic and Fabricated Metal (12), the embedded value added imported is significantly greater than its gross import counterpart. This implies that local labour markets specialised in these products are affected more than one might expect from studying gross import data.

Figure 1: Imports and Imported Value Added by Manufacturing Industry

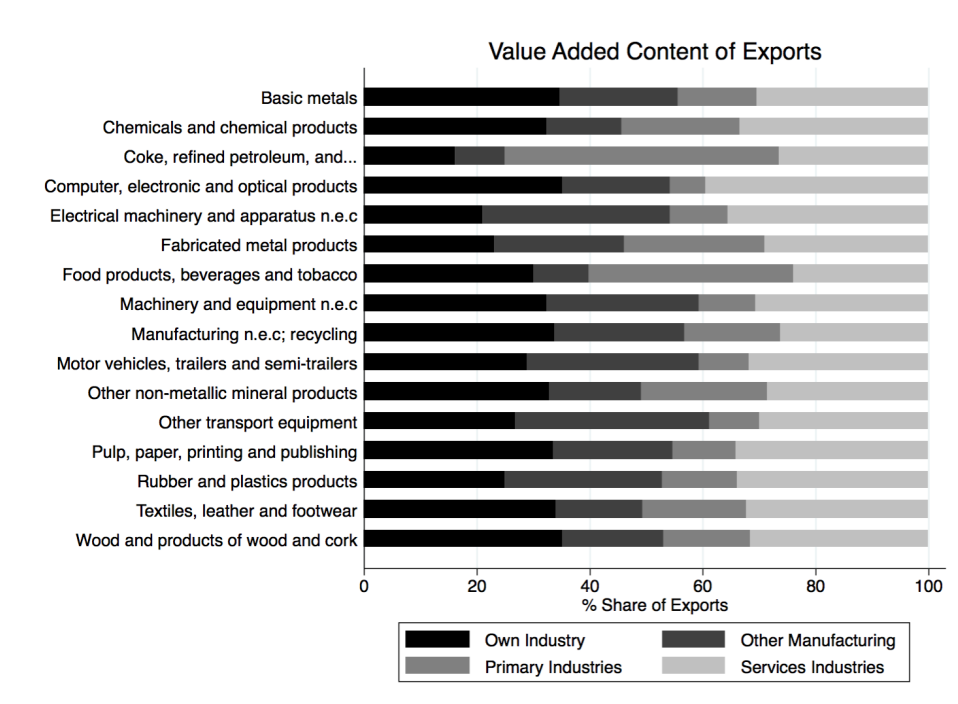


Notes: WIOD codes for manufacturing industries: 3 Food, Beverages and Tobacco; 4 Textiles and Textile Products; 5 Leather, Leather and Footwear; 6 Wood and Products of Wood and Cork; 7 Pulp, Paper, Paper, Printing and Publishing; 8 Coke, Refined Petroleum and Nuclear Fuel; 9 Chemicals and Chemical Products; 10 Rubber and Plastics; 11 Other Non-Metallic Mineral; 12 Basic Metals and Fabricated Metal; 13 Machinery, Nec; 14 Electrical and Optical Equipment; 15 Transport Equipment; 16 Manufacturing, Nec; Recycling.

Figure 2 Illustrates that the value added content of Chinese exports to the US does not solely originate from the exporting industry, but also from other upstream industries that supply inputs to the exporting industry. Different shades represent the source industries of the value added content in the exports of each manufacturing industry. The industry with the largest share is usually the nominal exporting industry, however it is clear that a significant share of value added – and labour – content is contributed by other manufacturing industries, as well as primary and services industries. It is important to note that the value added decomposition of bilateral exports does not simply take into account the direct inputs to production but also the inputs of these inputs, and so on.

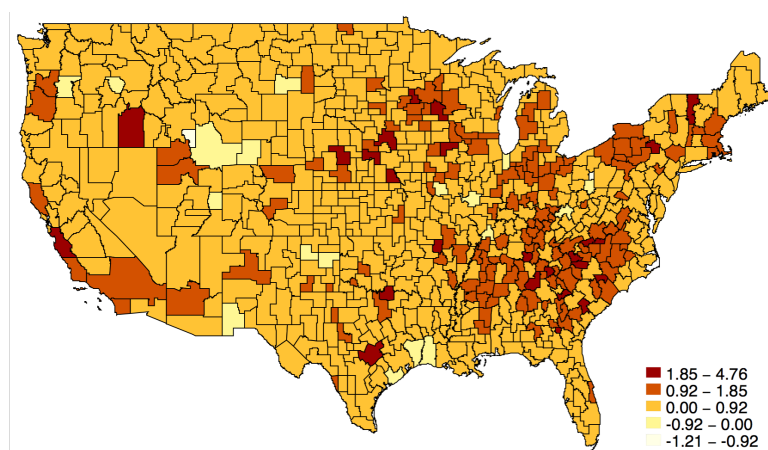
Given these insights, we follow ADH in constructing an exposure measure based on beginning-of-period local employment in manufacturing industries, but assign import competition to labour markets according to which industries supplied the value added content rather than to the exporting industry in order to better understand the local geography of exposure to the rise of

Figure 2: Industry-level value added content of exports



China.<sup>6</sup> As expected and as first result, we observe that the geographic pattern differs markedly from gross import based exposure measures.

Figure 3: Difference Between Import Value and Value Added Exposure Measures



Notes: Exposure is calculated based on import growth over the 2000-2007 period. Trade data is sourced from the TiVA database.

In Figure 3 we wish to highlight the differences in local labour market exposure using the two different approaches. For comparability the two types of exposure are both calculated from the same source, that is, TiVA. The colour scale in Figure 3 differentiates between below and above one standard deviation (of gross trade based exposure) differences between the two exposure

<sup>6</sup>Since the OECD-WTO, ADB-WIOD, and WIOD databases have been balanced so that worldwide trade flows are mirrored, we first confirmed that the differences in the geography of exposure are not due to using a different dataset compared to UN Comtrade, the database used by ADH.

measures in either direction. The exposure measure described in equation (1) is calculated with  $s$  representing the exporting industry in gross trade flows or with  $s$  representing the value added industry.

In Washington, Oregon, and California we observe several CZs that display high gross import exposure but much lower value added exposure. Even though these CZs appear directly exposed to import competition, it is actually jobs located elsewhere that are at risk. The opposite holds amongst others for Indiana and Texas. There are six local labour markets where exposure calculated using gross trade flows rather than value added flows differs by more than one standard deviation. The regions in question are located in or around Minneapolis, Minnesota; Nashville, Tennessee; San Jose, California; Northwest Indiana; Central New York; and Jackson, Mississippi. As an example, San Jose is famously associated with Silicon Valley and plays host to countless high tech and electronics jobs. As we know from Figure 1, it is this sector in particular where value added imports were much lower than gross imports. Turning attention to areas where value added exposure was greater than gross import exposure, we observe that out of the top ten such areas six are located in Texas. This is not surprising given the prominence of the Petroleum and Chemical sectors in Texas which are located upstream in the value chain of typical manufactured imports. Even less surprising is the increase in some of the rust belt areas and most strongly in Northwest Indiana which is the seat of the largest North American steel factories for both U.S. Steel (Gary, Indiana<sup>7</sup>) and ArcelorMittal (East Chicago, Indiana).

Revising the spatial distribution of exposure to import competition has important ramifications for policy makers attempting to understand and respond to the impact of trade shocks on their constituencies. It can help to design better local policies as well as federal place based policies that are needed to share the gains from trade as widely as possible as has recently been emphasised by various researchers and institutions (e.g. IMF, World Bank, WTO, 2017; WTO, 2017; Criscuolo et al., 2018). It can also help improve our understanding of the political economy processes underlying trade policy making in legislatures since it matches electoral districts more precisely to import competition and shows more clearly which constituencies are competing with foreign suppliers.

Finally, there are econometric implications of using a more accurate geographic exposure measure for the effects of the trade shock. For instance, some labour markets specialised in downstream industries are falsely assigned to the treated group rather than the control group introducing measurement bias. If detrimental employment effects have been less severe in California or Oregon, where some areas were incorrectly considered treated, then correcting this mis-assignment would imply a greater negative coefficient of trade exposure. At the same time, since the shift of exposure is not random but systematic from downstream to upstream industries, the coefficient might move in the positive direction if there is a systematic difference between upstream and downstream industries in terms of resilience to import competition. Upstream sectors are perhaps more resilient since they can switch to supplying other industries, and this channel is potentially significant if one accounts for the aggregate demand boosting effects due to trade liberalisation through the lowering of consumer prices and subsequent increases in disposable

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<sup>7</sup>Which coincidentally is also home of the immortal Jackson 5.

income. We seek to answer this empirical question in the section below.

## 5 Econometric Results

### 5.1 Comparison with ADH

We are interested in the effects of trade exposure on local manufacturing employment and we follow closely the preferred specification of ADH with the full set of controls. The dependent variable is the change in the share of working-age population employed in manufacturing in each CZ. Each observation is weighted by population.

$$\Delta MANUF_{it} = \beta_0 + \beta_1 \Delta EXP_{it} + \mathbf{X}'_{it} \gamma + \epsilon_{it} \quad (3)$$

In Table 1 we present the results of 2SLS estimates of this specification. In Column 1 we use the data from ADH to replicate results for the 2000-2007 period only, using their 10-year equivalent exposure, since they only publish results for a stacked first differences specification involving also the 1990-2000 time period, which our data does not cover. In Column 2 we use our data to construct a gross trade based trade exposure measure adjusted to be 10-year equivalent for comparability. We do this since we believe these, rather than the estimates based on COMTRADE data from ADH, are the relevant comparison for our benchmark results in Column 3, since the data source is kept the same and only the definitions of exposure vary. Column 3 presents results using our value added based exposure measure.

We confirm that the qualitative conclusions of ADH are robust, however the coefficients of value added exposure in Column 3 are much larger. In our benchmark results, a USD 1000 increase in imports per manufacturing worker decreases the share of manufacturing employment by 1.20 percentage points. Given large decreases in exposure for certain local labour markets such as Silicon Valley and large increases for the Texas Bay Area and North-West Indiana, this difference can translate into very different conclusions for some localities.

A benchmarking exercise assuming that trade exposure not only explains relative differences between commuting zones but also absolute differences is conducted in ADH. While useful as a comparison between models, we believe the assumption that unexposed local labour markets did not benefit from increased trade with China through a demand boosting price reduction channel is not plausible, and therefore the absolute decline in the level of manufacturing shares explained by the model in this benchmarking exercise is overestimated. Nevertheless this exercise helps to compare the value added with the gross approach. Taking the results in Column 1 using the data of ADH, the coefficient of the change in exposure is -0.469 and the average change in exposure over 2000-2007 weighted by CZ population was 1.839. Therefore the actual effect of exposure is the product of the two, a 0.862 percentage points decline. Given that the actual decline was 2 percentage points, the model explains 43% of the manufacturing jobs lost.

Repeating the exercise for our gross trade exposure measure in Column 2, the coefficient is -0.799,

but the average change in exposure over 2000-2007 weighted by CZ population was only 1.50, and therefore the effect of exposure was -1.20 percentage points, or 59.8% of manufacturing jobs lost. Using our value added based exposure measure in Column 3, the coefficient of exposure is -1.202 while the average change in exposure over 2000-2007 weighted by CZ population was 0.75, yielding an effect of exposure of -0.903 percentage points or 45.2% of manufacturing jobs lost.<sup>8</sup> Since the relevant comparison in terms of data consistency is between Columns 2 and 3, we find that using gross trade exposure overstates by 32.3% the share of jobs lost which can be attributed the the trade shock under these strong assumptions.

Table 1 — A Comparison of Local Labour Market Exposure Measures

Dependent Variable: 10-year equivalent change in manufacturing employment / working-age population in % pts			
	(1)	(2)	(3)
Local exposure to Chinese exports / worker	-0.469*** (0.123)	-0.799*** (0.147)	-1.202*** (0.295)
% manufacturing employment t-1	-0.083*** (0.025)	-0.129*** (0.0305)	-0.163*** (0.0279)
% college educated population t-1	-0.000 (0.021)	0.00122 (0.0228)	-0.0102 (0.0237)
% foreign born t-1	0.057*** (0.013)	-0.00728 (0.0233)	-0.00968 (0.0244)
% employment among women t-1	-0.064 (0.039)	0.0221 (0.0438)	0.0268 (0.0470)
% employment in routine occupations t-1	-0.142 (0.093)	-0.248*** (0.0655)	-0.228*** (0.0820)
avg offshorability of occupations t-1	-0.670* (0.344)	-0.154 (0.478)	-0.508 (0.579)
Constant	-1.182 (3.270)	6.528* (3.590)	6.166 (4.112)
Observations	722	722	722
R-squared	0.532	0.651	0.632
Census division dummies	YES	YES	YES
2SLS first stage estimates			
Instrumental Variable	0.528*** (0.0965)	0.755*** (0.0326)	0.740*** (0.0321)
Adjusted R-squared	0.517	0.905	0.928
Robust F	29.2963	527.251	521.698

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

## 5.2 Trade flows decomposed

Beyond improving the accuracy of the exposure measure, our data also allows us to distinguish between the true origins of the value added embedded in Chinese exports to the US. Given the remarkable expansion of Global Value Chains in the 1990s and 2000s this is relevant because it enables us to test whether the labour market effects of Chinese imports are driven by factors

<sup>8</sup>If we were to consider only the exogenous supply-driven component of exposure, a simple variance decomposition that uses the relationship between OLS and 2SLS estimates would indicate that its effects are only about half of this.

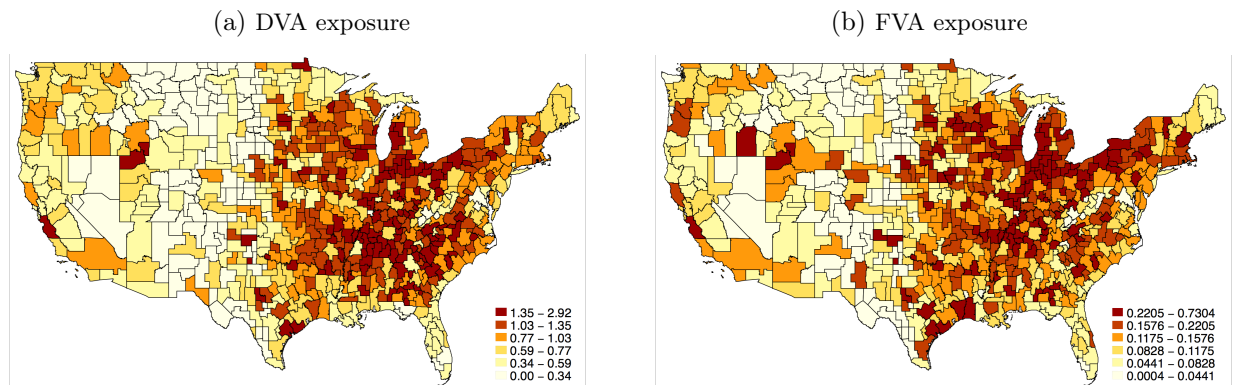
specific to China, such as domestic productivity-enhancing reforms, or whether they are due to third countries gaining competitiveness by using China as assembly hub. This has important implications for bilateral trade policy because in the latter case China could easily be replaced by alternative low-cost countries if bilateral trade policy barriers were to be erected while in the former case relocation would imply losing access to a China-specific productivity multiplier.

Therefore, we separate US imports from China into DVA, representing Chinese domestic value added, and FVA, representing foreign third-country value added, with US value added still excluded. Figure 4 presents two maps contrasting the geographic distribution of DVA and FVA. The specification used in this section is described in equation (4).

$$\Delta MANUF_{it} = b_0 + b_1 \Delta DV AEX P_{it} + b_2 \Delta FV AEX P_{it} + \mathbf{X}'_{it} b_3 + e_{it} \quad (4)$$

In order to separately identify the causal effects of these two treatment variables on manufacturing employment, it is a prerequisite that the industry compositions of DVA and FVA are sufficiently different. We can confirm from Figure 4 that the geographic pattern of these two exposures indeed varies and allows for an identification. Even though DVA exposure is generally greater in magnitude, we see important heterogeneity across industries. What stands out is that downstream industries, in particular electrical machinery and electronic equipment, contain a high share of foreign value added (72% FVA in 2000) while upstream industries such as the basic metals industry (e.g. steel) contain predominantly Chinese value added (28% FVA in 2000). The reason for this variation in the industry composition of DVA and FVA is an interesting topic of research in its own right. This could be attributed to comparative advantage stemming from the varying resource endowments of China and FVA contributors, China moving up the value chain as its economy develops, or a combination of factors.

Figure 4: Comparison of DVA and FVA exposure 2000-2007



Notes: DVA represents Chinese domestic value added in US imports from China, FVA represents foreign third-country value added with US value added excluded. Exposure is calculated based on import growth over the 2000-2007 period. Trade data is sourced from the TiVA database.



Table 2 — Local labour market exposure by origin of value added for the period 2000-2007  
 Dependent Variable: 7-year change in manufacturing employment / working-age population in % pts

	(1)
Local exposure to the Chinese value added content of Chinese exports / worker	-2.991*** (1.476)
Local exposure to the Foreign value added content of Chinese exports / worker	1.149 (2.056)
% manufacturing employment t-1	-0.0817*** (0.0252)
% college educated population t-1	-0.0128 (0.0178)
% foreign born t-1	0.00771 (0.0177)
% employment among women t-1	0.0153 (0.0340)
% employment in routine occupations t-1	-0.137** (0.0564)
avg offshorability of occupations t-1	-0.424 (0.431)
Constant	4.017 (2.944)
Observations	722
R-squared	0.629
Census division dummies	YES

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 2 reports results from this decomposition exercise. We see that the coefficient of DVA exposure is negative and significant. Contrary to this, the coefficient of FVA exposure is positive and not significant. This suggests that the negative effect on exposed local labour markets is caused exclusively by imports of Chinese value added. Given that the DVA content is particularly high in certain upstream industries and the opposite holds for certain downstream industries, the results mirror our findings on the difference between effects obtained using value added and gross imports. As discussed, using value added instead of gross imports shifted exposure from downstream to upstream industries. This, in turn, increased the coefficient that reports the impact of imports on manufacturing employment considerably. As a result, our decomposition result is consistent since these upstream imports that lifted the coefficient contain mostly DVA.

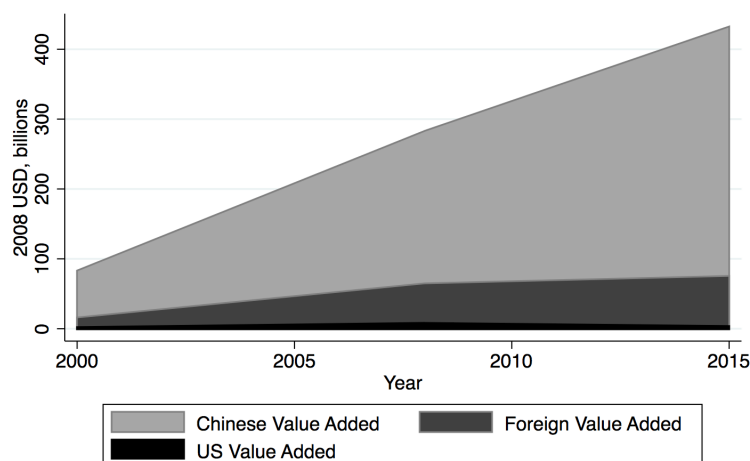
While this type of reduced form analysis cannot identify the exact source of the shock, whether it is a Chinese productivity increase or simply the political decision to integrate more deeply into the world economy, we can say that the drivers of the shock are Chinese in origin as hypothesised by ADH. We can also discount the hypothesis that the shock is driven by other advanced economies rerouting production through China via global value chains. In fact, the negative effect of DVA indicates that manufacturing employment has been affected the most in CZs whose industry

structure corresponds to industries in which Chinese value added has expanded, highlighting a degree of substitutability. In contrast, manufacturing employment was unaffected in CZs whose industry structure mirrors the industry composition of increased FVA. This could indicate a broad shift across developed countries to expand manufacturing sectors where they maintain a comparative advantage over China in response to increased import competition in other sectors. It is also the case that the FVA component does not necessitate new adjustment as countries such as the US have been exposed to imports from countries such as Japan and Korea for a long time. Moreover, if we sum up the total value added that key exporters send to the US, independent of the exact route these exports take, that is, independent whether they travel to the US directly or via third countries such as China, we observe in the data that the expansion of Japanese, German, or Korean exports to the US via China comes at the expense of direct exports. This means that there is no FVA import shock but simply a re-routing that does not affect the growth rate of total imported value added from these countries. DVA on the other hand expanded dramatically causing the observed response.

### 5.3 Extending the analysis until 2014

A similarly important question for trade policy with regards to Chinese import competition is whether labour markets can adjust to import competition. This is particularly important in light of our previous results because while the expansion of GVCs has stalled since the early 2010s, exports of Chinese value added, which are as we have shown responsible for labour market adjustment, continued to rise. As Figure 5 illustrates, the expansion of the import shock up until 2015 is due to the DVA component, whereas after 2008 the FVA component has on aggregate stayed level, and the US value added component has slightly contracted.

Figure 5: Chinese Manufacturing Exports to the US Decomposed by Source Country of Value Added



We proceed to analyse the persistence of local labour market effects in the more recent period 2008-2014. For this exercise we use data from the Asian Development Bank multi-regional input-output tables (ADB-MRIO) since TiVA data for more recent years is yet to be made available.

Adjusting the data to to even 8-year equivalent period lengths, we test our specification for each period separately, allowing covariates to have time dependent effects.

Column 1 in Table 3 uses data only for the first period, without any period length adjustment for comparability with ADH. These results replicate our benchmark specification using the ADB-MRIO data. Column 2 shows that the import shock from the 2000-2008 period no longer has significant effects in the second (2008-2014) period. Column 3 shows that, despite the continued expansion of Chinese imports, the send period shock has no significant employment effects in that period, whereas employment in routine occupations and offshorability are significant factors. Given that the second period contains the aftermath of the 2008 global financial crisis where presumably there were strong demand comovements between advanced economies, one concern is that the estimates of the effects of the import shock are biased towards zero because of the invalidity of the ADH instrumentation strategy under these conditions. We therefore redo this analysis in Column 4 using the the pre-crisis 2000-2008 instrument for the post-crisis 2008-2014 trade shock. We find a larger but statistically insignificant coefficient in this specification. Lastly, in Column 5 we include both the first period and second period import shocks together, and find no statistically significant effects. These results are consistent with our hypothesis that the manufacturing industries most vulnerable to import competition have for the most part already adjusted, leaving behind an industry structure that is more resilient to increasing volumes of import competition.

Bloom et al. (2016) posit that firms accelerate technological and organisational innovation to inoculate themselves against import competition, which could explain our findings. In recent research Magyari (2017) presents evidence showing that firms reorganise their production activities towards less exposed industries in response to trade shocks. While this may happen across CZ boundaries, leaving certain CZs no better off, it may to some extent attenuate the average local negative effects estimated. Further, given that some reorganisation takes place in the first period, the effects of further expansion of imports during the second period are likely to be smaller, as long as the industry composition of imports does not change significantly. However, we later show that the industry composition of imports from China does in fact evolve over time, which may partially account for the persistence of negative effects from exposure to certain subgroups of imports.

Table 3 — Extending the analysis to cover 2000-2014

Dependent Variable: 8-year equivalent change in manufacturing employment / working-age population in % pts					
Period Analysed	(1)	(2)	(3)	(4)	(5)
	(2000-2008)	(2008-2014)	(2008-2014)	(2008-2014)	(2008-2014)
Local exposure to Chinese exports / worker (2000-2008)	-1.219*** (0.363)	-0.335 (0.374)			-0.347 (0.458)
Local exposure to Chinese exports / worker (2008-2014)			-0.175 (0.541)	-1.036 (1.278)	0.0383 (0.669)
% manufacturing employment t-1	-0.111*** (0.0286)	-0.340*** (0.0289)	-0.354*** (0.0341)	-0.315*** (0.0596)	-0.341*** (0.0340)
% college educated population t-1	-0.00581 (0.0163)	0.0115 (0.0138)	0.0108 (0.0139)	0.0101 (0.0142)	0.0116 (0.0142)
% foreign born t-1	-7.28e-05 (0.0172)	0.0141 (0.0139)	0.0150 (0.0135)	0.0148 (0.0125)	0.0140 (0.0141)
% employment among women t-1	0.0279 (0.0331)	-0.0526** (0.0262)	-0.0514* (0.0266)	-0.0586** (0.0263)	-0.0523** (0.0267)
% employment in routine occupations t-1	-0.176*** (0.0591)	-0.105*** (0.0316)	-0.105*** (0.0321)	-0.0965*** (0.0352)	-0.106*** (0.0312)
avg offshorability of occupations t-1	-0.502 (0.416)	-1.033*** (0.288)	-1.065*** (0.294)	-1.046*** (0.281)	-1.032*** (0.287)
Constant	4.121 (3.038)	4.840** (2.157)	4.709** (2.191)	4.924** (2.090)	4.837** (2.173)
Observations	722	722	722	722	722
R-squared	0.642	0.874	0.874	0.871	0.874
Census division dummies	YES	YES	YES	YES	YES

Robust standard errors in parentheses

\*\*\* p&lt;0.01, \*\* p&lt;0.05, \* p&lt;0.1

Another concern is that in the post-crisis period, omitting to control for local employment in crisis hit industries such as finance, insurance and real estate (FIRE), and construction may bias our estimates due to local demand and labour supply effects. In Table 4 we show that our estimates are robust to controlling for employment share in these industries.

Table 4 — Extending the analysis to cover 2000-2014

Dependent Variable: 8-year equivalent change in manufacturing employment / working-age population in % pts			
	(1)	(2)	(3)
Period Analysed	(2000-2008)	(2008-2014)	(2008-2014)
Local exposure to Chinese exports / worker (2000-2008)	-1.243*** (0.366)		
Local exposure to Chinese exports / worker (2008-2014)		-0.101 (0.551)	-0.117 (0.547)
% FIRE employment 2000	0.0141 (0.0424)		-0.00468 (0.0490)
% FIRE employment 2008		-0.00796 (0.0337)	
% construction employment 2000	0.0550 (0.0506)		-0.0282 (0.0458)
% construction employment 2008		-0.0262 (0.0435)	
% manufacturing employment t-1	-0.104*** (0.0283)	-0.361*** (0.0365)	-0.359*** (0.0359)
% college educated population t-1	-0.00574 (0.0166)	0.0109 (0.0140)	0.0110 (0.0140)
% foreign born t-1	0.00123 (0.0172)	0.0150 (0.0137)	0.0143 (0.0133)
% employment among women t-1	0.0265 (0.0327)	-0.0491* (0.0254)	-0.0500* (0.0265)
% employment in routine occupations t-1	-0.178*** (0.0602)	-0.105*** (0.0307)	-0.106*** (0.0321)
avg offshorability of occupations t-1	-0.505 (0.419)	-1.077*** (0.291)	-1.067*** (0.296)
Constant	3.843 (3.124)	4.739** (2.210)	4.835** (2.221)
Observations	722	722	722
R-squared	0.643	0.875	0.875
Census division dummies	YES	YES	YES

Robust standard errors in parentheses

\*\*\* p&lt;0.01, \*\* p&lt;0.05, \* p&lt;0.1

The main conclusion from this section is that implementing bilateral trade policy measures that restrict imports from China cannot be justified on the grounds of protecting manufacturing employment. Rising imports from China since the most recent period no longer have any statistically significant differential effects on manufacturing employment across exposed and unexposed areas. Exposed areas have adapted their employment composition in a way that it is immune to rising competition. Restricting imports after such adjustment has taken place, would necessitate renewed costly adjustment. At the same time it is reasonable to assume that the positive effects of imports, such as lower consumer and input prices, continue to increase with rising imports which further speaks against trade barriers.

## 5.4 Comparative advantage sectors

A question that arises directly from section 5.3 is why adjustment to Chinese import competition has taken fairly long. Recent work by Hanson et al. (2015) has shown evidence for comparative advantage changing dynamically over time. It is well known that since the early 1990s China has expanded its set of comparative advantage manufacturing industries rapidly. Thus, we investigate the impact of Chinese value added exposure coming from industries grouped by the dynamics of their revealed comparative advantage in order to understand whether comparative advantage dynamics drive adjustment length.<sup>9</sup>

Specifically, the three groups used in our specification shown in equation 6 (*DVA1*, *DVA2*, and *DVA3* respectively) comprise exporting industries in which China has had a comparative advantage since 1995, industries in which China has gained a comparative advantage between 1995 and 2008, and industries in which China never had a comparative advantage. Table 4 lists the specific industries in each group as they are classified in the ADB-MRIO.

Table 5 — Industries According to Revealed Comparative Advantage Dynamics

Group 1 – Pre-1995 RCA	Group 2 – RCA Gained Since 1995	Group 3 – Never RCA
Food, Beverages and Tobacco	Wood and Products of Wood and Cork	Pulp, Paper, Printing and Publishing
Textiles and Textile Products	Chemicals and Chemical Products	Transport Equipment
Leather, Leather and Footwear	Machinery, Nec	
Coke, Refined Petroleum and Nuclear Fuel	Electrical and Optical Equipment	
Rubber and Plastics		
Other Non-Metallic Mineral		
Basic Metals and Fabricated Metal		
Manufacturing, Nec; Recycling		

$$\Delta MANUF_{it} = b_1 + b_2 \Delta DVA1EXP_{it} + b_3 \Delta DVA2EXP_{it} + b_4 \Delta DVA3EXP_{it} + b_5 \Delta FVAEXP_{it} + \mathbf{X}'_{it} b_5 + e_{it} \quad (5)$$

<sup>9</sup>We compute comparative advantage industries using the methodology of Balassa (1965) based on value added exports provided by TiVA.

Table 5 — Local labour market exposure by origin of value added for periods 2000-2008 and 2008-2014  
 Dependent Variable: 8-year equivalent change changes in manufacturing employment / working-age population in % pts

Period Analysed	(1)	(2)
	(2000-2008)	(2008-2014)
Local exposure to the Chinese DVA1 industry value added content of Chinese exports	-3.189** (1.351)	0.971 (1.570)
Local exposure to the Chinese DVA2 industry value added content of Chinese exports	-4.882*** (1.364)	-1.219 (0.918)
Local exposure to the Chinese DVA3 industry value added content of Chinese exports	1.275 (5.022)	-1.197 (6.039)
Local exposure to the Foreign value added content of Chinese exports / worker	9.075** (3.535)	-0.326 (4.386)
% manufacturing employment t-1	-0.0634 (0.0475)	-0.364 (.0652)
% college educated population t-1	-0.00755 (0.0173)	.0243 (0.0149)
% foreign born t-1	0.000393 (0.0177)	0.0139 (0.0140)
% employment among women t-1	0.0203 (0.0343)	-0.0534** (0.0266)
% employment in routine occupations t-1	-0.162*** (0.0584)	-0.122*** (.0333)
avg offshorability of occupations t-1	-0.432 (0.424)	-1.013*** (0.279)
Constant	4.075 (3.148)	4.780 (2.200)
Observations	722	722
R-squared	0.656	0.875
Census division dummies	YES	YES

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

We observe in Table 5 that in the first period, 2000-2008, exposure to DVA from the first two groups (original comparative advantage industries and newly acquired comparative advantage industries) is associated with negative effects on local manufacturing employment. The coefficient of the second group is larger significant at a 99% confidence level. The third group, where China never had a comparative advantage, has no significant effect. As in section 5.3, exposure to Chinese DVA in the period 2008-2014 has no statistically significant effects on manufacturing employment. However, among the three groups, the p-value of the newly acquired comparative advantage industries group is the lowest, and would imply a statistically significant negative effect at a 80% confidence level. The effects of FVA exposure are similar to the previous specification but statistically significant. We take these results as evidence that adjustment in labour markets has largely taken place despite the ongoing growth of imports from China, and that it might have been prolonged by some industries in which China has only relatively recently gained a competitive edge. The type of rolling adjustment necessitated by China's concurrent development and movement up the value chain could explain why it has taken close to two decades for US labour markets to adjust to the rise of China.

## 6 Conclusion

The literature on the local labour market effects of Chinese import competition has been cited extensively as an argument for limiting trade with China despite the fact that the results do not support this conclusion. While the differential effects of trade at a local labour market level are clear, its aggregate negative effects on manufacturing employment are subject to debate.

In this paper we provide explicit evidence that even if policy were narrowly focused on direct import competition effects ignoring price and indirect effects, there is no case for limiting trade with China. Using recent trade data, we show that rising US local labour market exposure to Chinese imports in the recent period 2008-2014 no longer has a statistically significant effect on the relative shares of manufacturing employment. This suggests that US local labour market adjustment to the China shock has largely concluded.

While bilateral trade barriers cannot be justified on empirical grounds, the rationale for adjustment policies to trade remains. Such adjustment policies require a precise understanding about which industries and regions are most affected by import competition. By exploiting a value added decomposition of trade flows, we improve on the accuracy of gross trade based measures of import exposure. We find that using gross trade exposure, as done by ADH and much of the recent literature, overstates the direct impact of Chinese imports on US manufacturing jobs by 32.3% over the 2000-2007 period. These differences are partly because the volume of the trade shock is smaller once only value added from manufacturing industries is considered, and partly because the geographical distribution of import exposure is different. Using our value-added-based exposure measure changes the spatial distribution of import exposure markedly with important implications for interventions to facilitate adjustment and political economy analyses. Moreover, the decomposition allows us to contribute an important methodological innovation that complements the empirical strategy of ADH with a cleaner identification of the causal effects of import exposure by removing US valued added from Chinese exports to the US, which constitutes a mechanically endogenous component.

Finally, this paper adds to our understanding of the drivers behind the rise of China. By splitting Chinese exports into a Chinese part and a part of third country inputs into Chinese production, we provide evidence that confirms the hypothesis of Autor et al. (2016) that the local labour market effects are driven by changes specific to China rather than the proliferation of GVCs which have increasingly incorporated China in downstream production stages.

We find it important to emphasise and to make clear that while the focus of this line of research has so far been on the effects of import competition which necessitates labour market adjustment in the short run, there are other channels in general equilibrium through which bilateral trade relations with China have welfare improving effects, and an evaluation of policy should take into account both sides of the coin. While the China shock was a unique historical event, we can expect the labour market to be affected by disruptive technology shocks in the future, and therefore, the lessons from the China shock and its impact in different countries could potentially inform the debate about optimal domestic labour market policies aimed at facilitating adjustment.



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## Appendix

### The China Shock revisited: Insights from value added trade flows: Value added decomposition of gross trade flows at bilateral-sector level

In this section we aim to familiarise the reader with the basics of value added decomposition frameworks in order to provide some insight on how our more detailed trade data is generated. Getting to the value added structure of gross trade at a disaggregated level requires taking into account the differences between final and intermediate goods using more techniques that go beyond the standard Leontief decomposition. Wang et al. (2013) propose an accounting framework which builds on Koopman et al. (2014) using additional information found in ICIOs on the subsequent uses and final destinations of foreign value added inputs to domestic industry. For a detailed exposition we refer the reader to original papers. Our data applies their framework to the ADB-MRIO table and completely decomposes gross exports into four major categories: domestic value added absorbed abroad, domestic value added that returns home, foreign value added, and double-counted intermediate trade.

Below is the final decomposition for a simple two country one industry model (equation 22 in Wang et al. (2013)).

$$\begin{aligned}
E^{kl} = & (V^k B^{kk})^T * F^{kl} + (V^k L^{kk})^T * (A^{kl} B^{ll} F^{ll}) \\
& + (V^k L^{kk})^T * (A^{kl} \sum_{t \neq k, l}^G B^{lt} F^{tt}) + (V^k L^{kk})^T * (A^{kl} B^{ll} \sum_{t \neq k, l}^G F^{tt}) \\
& + (V^k L^{kk})^T * (A^{kl} \sum_{t \neq k, l, u \neq k, t}^G \sum_{u \neq k, t}^G B^{lt} F^{tu}) + (V^k L^{kk})^T * (A^{kl} B^{ll} F^{lk}) \\
& + (V^k L^{kk})^T * (A^{kl} \sum_{t \neq k, l}^G B^{lt} F^{tk}) + (V^k L^{kk})^T * (A^{kl} B^{lk} F^{kk}) \\
& + (V^k L^{kk})^T * (A^{kl} \sum_{t \neq k}^G B^{lk} F^{kt}) + (V^k B^{kk} - V^k L^{kk})^T * (A^{kl} X^l) \\
& + (V^l B^{lk})^T * F^{kl} + (V^l B^{lk})^T * (A^{kl} L^{ll} F^{ll}) + (V^l B^{lk})^T \\
& * (A^{kl} L^{ll} E^{l*}) + (\sum_{t \neq k, l}^G V^t B^{tk})^T * F^{kl} + (\sum_{t \neq k, l}^G V^t B^{tk})^T \\
& * (A^{kl} L^{ll} F^{ll}) + (\sum_{t \neq k, l}^G V^t B^{tk})^T * (A^{kl} L^{ll} E^{l*}),
\end{aligned} \tag{6}$$

Here  $E^{kl}$  represents exports from country  $k$  to  $l$ ,  $F^{kl}$  is the final demand in  $l$  for goods of  $k$ ,  $L^l$  refers to the national Leontief inverse as opposed to the Inter-Country inverse  $B$ , and  $T$  indicates a matrix transpose operation. As can be seen from equation (6), this decomposition splits gross exports into 16 linear terms with four main categories which are subdivided by final destination, as described below.

- Domestic value added absorbed abroad ( $vax\_g$ , T1-5)
  - Domestic value added in final exports ( $dva\_fn$ , T1)
  - Domestic value added in intermediate exports ( $dva\_intt$ , T2-5)

- \* Domestic value added in intermediate exports absorbed by direct importers ( $dva\_int$ , T2)
- \* Domestic value added in intermediate exports re-exported to third countries ( $dva\_intrex$ , T3-5)
  - Domestic value added in intermediate exports re-exported to third countries as intermediate goods to produce domestic final goods ( $dva\_intrexi1$ , T3)
  - Domestic value added in intermediate exports re-exported to third countries as final goods ( $dva\_intref$ , T4)
  - Domestic value added in intermediate exports re-exported to third countries as intermediate goods to produce exports ( $dva\_intrexi2$ , T5)
- Domestic value added returning home ( $rdv$ , T6-8)
  - Domestic value added returning home as final goods ( $rdv\_fin$ , T6)
  - Domestic value added returning home as final goods through third countries ( $rdv\_fin2$ , T7)
  - Domestic value added returning home as intermediate goods ( $rdv\_int$ , T8)
- Foreign value added ( $fva$ , T11-12/14-15 )
  - Foreign value added in final good exports ( $fva\_fin$ , T11/14)
    - \* Foreign value added in final good exports sourced from direct importer ( $mva\_fin$ , T11)
    - \* Foreign value added in final good exports sourced from other countries ( $ova\_fin$ , T14)
  - Foreign value added in intermediate good exports ( $fva\_int$ , T12/15)
    - \* Foreign value added in intermediate good exports sourced from direct importer ( $mva\_int$ , T12)
    - \* Foreign value added in intermediate good exports sourced from other countries ( $ova\_int$ , T15)
- Pure double counting ( $pdv$ , T9-10/13/16)
  - Pure double counting from domestic source ( $ddc$ , T9-10)
    - \* Due to final goods exports production ( $ddf$ , T9)
    - \* Due to intermediate goods exports production ( $ddi$ , T10)
  - Pure double counting from foreign source ( $fdc$ , T13/16)
    - \* Due to direct importer exports production ( $fdf$ , T13)
    - \* Due to other countries' exports production ( $fdi$ , T16)

It is due to this decomposition that we are able to disregard double counted terms in our analysis, and to split our bilateral exports into country-industry level *DVA* and *FVA* components. Note that Koopman et al. (2014) split the *PDC* term further into domestic and foreign content based on the origins of the double counted terms whereas here the entire *PDC* term is kept intact and apart from domestic value-added in order to allow total bilateral *DVA* to remain net of double counting.